NOTICE

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(DE92000454)

ANCILLARY OPERATIONS IN COAL PREPARATION INSTRUMENTATION ON-LINE LOW COST SULFUR AND ASH ANALYZER

Final Report

By
M. L. Malito

July 1991

Work Performed Under Contract No. AC22-88PC88882

For
U.S. Department of Energy
Pittsburgh Energy Technology Center
Pittsburgh, Pennsylvania

By
The Babcock & Wilcox Company
Alliance, Ohio

DOE/PC/88882--1-App.A-I

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(B&W RDD 91:4554-07-01:01)

Prepared by

M. L. Malito

Sponsored by

The U.S. Department of Energy
Pittsburgh Energy Technology Center
P.O. Box 10940
Pittsburgh, Pennsylvania 15236

Work Performed under Contract DE-AC22-88PC88882

The Babcock & Wilcox Company
Research and Development Division
Alliance Research Center
1562 Beeson Street
Alliance, Ohio 44601

APPENDIX A

GRINDER TESTING AT NETZSCH LABORATORIES

NETZSCH INCORPORATED
GRINDING & DISPERSION EQUIPMENT DEPARTMENT

January 10, 1990

Dr. Randy Sarkis
Babcock & Wilcox
1562 Beeson Avenue
Alliance, OH 44601

Dear Randy:

Attached please find the test data for grinding the Pittsburgh # 8 and upper freeport coals.

Should you have any further questions please do not hesitate contacting either our sales representative, Maroon Chemical, (216) 333-0020, or our office.

Best regards,

Harry Way
Manager, Customer Service Laboratory

CC: Mr. Mark Reichard

119 PICKERING WAY, EXTON, PA 19341-1393 • (215) 363-8010 • TELEX: 173237 • EASYLINK: 62775745

LABORATORY TEST DATA SHEET

Date of test: 01/05/90	Test Number: 2/2528/90
Company Name	Babcock & Wilcox
Present From Customer	
Present from Netzsch	Brad Titus, Harry Way
Product	Coal, Illinois # 6, Upper Freeport

PASS / VARIATION	# 6 1/1	# 6 1/2	UF 1/3	UF 1/4		
Pigment Solids (%)	20.0	5.0	20.0	5.0		
Dispersant (% by weight of coal)	1.0	1.0	1.0	1.0		
Solvent (%)	80.0	95.0	80.0	95.0		
Inlet Product Viscosity (cp)						
Inlet Product Temp. (C)	22.0	22.0	22.0	22.0		
Mill Type	LME 4	LME 4	LME 4	LME 4		
Motor Power (Hp)	5.0	5.0	5.0	5.0		
Max. Amperage at 480 Volts	7.6	7.6	76.0	7.6		
Pump Type	NES20	NES20	NES20	NES20		

Media Type	Steel	Steel	Steel	Steel		
Media Size (mm)	1.1 x 1.1	1.1 x 1.10	1.1 x 1.10	1.1 x 1.10		
Media Charge (%)	90	90	90	90		
Cooling Water Inlet Temp. (C)	8.0	8.0	8.0	8.0		
Cooling Water Outlet Temp. (C)						
Cooling Water Flow Rate (l/min)	20.0	20.0	20.0	20.0		
Agitator Speed (rpm)	1890	1989	1832	1843		
Production Rate (l/min)	1	1	1	1		
Residence Time (min)	1.91	1.91	1.91	1.91		
Product Outlet Viscosity (cp)						
Product Outlet Temp. (C)	27.0	27.0	27.0	27.0		
Chamber Pressure (bar)	0.00	0.00	0.00	0.00		
Current Consumption (amps)	7.90	7.50	7.50	6.50		
Fineness Microns, 90 % <	17.73	23.1	10.21	13.64		
Obtained MV (Mean Volume Dia.)	8.83	12.08	4.83	6.31		
Sample Identification	1	2	3	4		

Working Volume Calculations   Remarks

LME 4 at 90 % :

(4.15 Liters * 0.9 * 0.4) + (4.15 * 0.1) = 1.91 Liters

LABORATORY TEST DATA SHEET

Date of test: 11/17/89 — Test Number: 2/2521/89

Company Name	Babcock and Wilcox
Present From Customer	
Present from Netzsch	Brad Titus, Harry Way
Product	Coal water slurry, Pittsburgh # 8

PASS / VARIATION	1/1	1/2	1/3			
Pigment Solids (%)	20.0	20.0	20.0			
Dispersant (%)	1.0	1.0	1.0			
Solvent (%)	79.0	79.0	79.0			
Inlet Product Viscosity (cp)						
Inlet Product Temp. (C)	20.0	20.0	20.0			
Mill Type	LME 4	LME 4	LME 4			
Motor Power (Hp)	5.0	5.0	5.0			
Max. Amperage at 480 Volts	7.6	7.6	7.6			
Pump Type	NES20	NES20	NES20			
Media Type	Steel	Steel	Steel			
Media Size (mm)	1.1 x 1.1	1.1 x 1.10	1.1 x 1.10			
Media Charge (%)	90	90	90			
Cooling Water Inlet Temp. (C)						
Cooling Water Outlet Temp. (C)						
Cooling Water Flow Rate (l/min)	30.0	30.0	30.0			
Agitator Speed (rpm)	2160	2163	2163			
Production Rate (l/min)	1	0.5	0.25			
Residence Time (min)	1.91	3.82	7.64			
Product Outlet Viscosity (cp)						
Product Outlet Temp. (C)	34.0	42.0	45.0			
Chamber Pressure (bar)	0.00	0.00	0.00			
Current Consumption (amps)	7.00	6.70	6.30			
Fineness Microns, 90 % <	12.31	11.19	10.66			
Obtained MV (Mean Volume Dia.)	5.65	5.44	5.15			
Sample Identification	1/1	1/2	1/3			

Working Volume Calculations — Remarks

LABORATORY TEST DATA SHEET

Date of test: 10/20/89	Test Number: 2/2515/89
Company Name	Babcock & Wilcox
Present From Customer	Randy Sarkis
Present from Netzsch	Harry Way
Product	Coal Water slurry, upper freeport, cleaned

PASS / VARIATION	1/1	1/2	1/3	1/4		
Pigment Solids (%)	20.0	20.0	20.0	20.0		
Solvent (%)	80.0	80.0	80.0	80.0		
Inlet Product Viscosity (cp)						
Inlet Product Temp. (C)						
Mill Type	LME 4	LME 4	LME 4	LME 4		
Motor Power (Hp)	5.0	5.0	5.0	5.0		
Max. Amperage at 480 Volts	7.6	7.6	7.6	7.6		
Pump Type	NES20	NES20	NES20	NES20		
Media Type	Steel	Steel	Steel	Steel		
Media Size (mm)	2	2.00	2.00	2.00		
Media Charge (%)	80	80	80	80		
Cooling Water Inlet Temp. (C)	9.0	7.0	7.0	7.0		
Cooling Water Outlet Temp. (C)	12.0	10.0	10.0	10.0		
Cooling Water Flow Rate (l/min)	12.0	12.0	12.0	12.0		
Agitator Speed (rpm)	2200	2200	2200	2200		
Production Rate (l/min)	1	0.56	0.26	2.1		
Residence Time (min)	2.16	3.90	8.30	1.00		
Product Outlet Viscosity (cp)						
Product Outlet Temp. (C)	23.0	23.0	24.0	24.0		
Chamber Pressure (bar)	0.20	0.00	0.00	0.20		
Current Consumption (amps)	6.50	6.00	5.70	6.00		
Fineness Microns, 90 % <	23.23	20.82	17.4	26.85		
Obtained MV (Mean Volume Dia.)	10.78	9.53	7.91	12.34		
Sample Identification	1	2	3	4		

Working Volume Calculations **Remarks**

LME 4 at 80 % ball charge :
(4.15 liters * 0.80 * 0.40) + (4.15 Liters * 0.20) = 2.16 liters

LABORATORY TEST DATA SHEET

Date of test: 10/20/89	Test Number: 2/2515/89
Company Name	Babcock & Wilcox
Present From Customer	Randy Sarkis
Present from Netzsch	Harry Way
Product	Coal/water slurry, Pittsburgh # 8 -100 mesh

PASS / VARIATION	1/8	1/9	1/10			
Pigment Solids (%)	20.0	20.0	20.0			
Solvent (%)	80.0	80.0	80.0			
Inlet Product Viscosity (cp)						
Inlet Product Temp. (C)						
Mill Type	LME 4	LME 4	LME 4			
Motor Power (Hp)	5.0	5.0	5.0			
Max. Amperage at 480 Volts	7.6	7.6	7.6			
Pump Type	NES20	NES20	NES20			
Media Type	Steel	Steel	Steel			
Media Size (mm)	2	2.00	2.00			
Media Charge (%)	80	80	80			
Cooling Water Inlet Temp. (C)	7.0	7.0	7.0			
Cooling Water Outlet Temp. (C)	10.0	10.0	10.0			
Cooling Water Flow Rate (l/min)	12.0	12.0	12.0			
Agitator Speed (rpm)	2200	2200	2200			
Production Rate (l/min)	1	0.5	0.25			
Residence Time (min)	2.16	4.30	8.60			
Product Outlet Viscosity (cp)						
Product Outlet Temp. (C)	22.0	25.0	25.0			
Chamber Pressure (bar)	0.10	0.00	0.00			
Current Consumption (amps)	6.00	5.90	5.80			
Fineness Microns, 90 % <	24.17	20.21	18.65			
Obtained MV (mean volume dia.)	11.24	9.51	8.89			
Sample Identification	8	9	10			

Working Volume Calculations

Remarks

APPENDIX B

TEST PLAN FOR ANALYSIS OF FIELD COLLECTED COAL SLURRIES BY ICP-AES

ANCILLARY OPERATIONS IN COAL PREPARATION

ON-LINE LOW-COST SULFUR AND ASH ANALYSIS

TEST PLAN

FOR

ANALYSIS OF FIELD COLLECTED COAL SLURRIES
BY ICP-AES

Prepared by:
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The Babcock & Wilcox Company
Research and Development Division
1562 Beeson Street
Alliance, Ohio 44601

Prepared for:
U. S. Department of Energy
Pittsburgh Energy Technology Center
P. O. Box 10940
Pittsburgh, PA 15236-0940

DOE: DE-AC22-88PC88882
B&W CRD 1222

DRAFT NOV 28,1990

1. Introduction/Scope

The purpose of this document is to define the testing to be performed on field collected coal slurry samples by ICP-AES (Inductively Coupled Plasma-Atomic Emission Spectroscopy). A total of 20 samples (8 from an Upper Freeport coal and 12 from an Oklahoma coal) are to be analyzed in triplicate for the elements S, Si, Al, Fe, Ca, AND Mg.

For each of the two coal slurry types (Upper Freeport and Oklahoma), a container of slurry labeled "calibration" has been prepared. These calibration slurries may be used to get the system "tuned" (note that the volume of the field collected slurries is relatively small and cannot be used to "tune" the system). The calibration slurries were made from the slurry collected from the drain from the second sampling stage during the field testing.

2. Equipment

a B&W ICP-AES. Model Applied Research Laboratories 35000 C ICP consisting of RF-generator, "torch box", Argon supply, Argon purged spectrometer, DEC PDP11/03L microprocessor, and DEC-writer printer.

b Nebulizer/Spray Chamber.

ARL MDSN (see figure 1)

c Slurry feed pump.

Gilson Peristaltic Pump
Model Minipuls 3
S/N 618A9045

d Mixer.

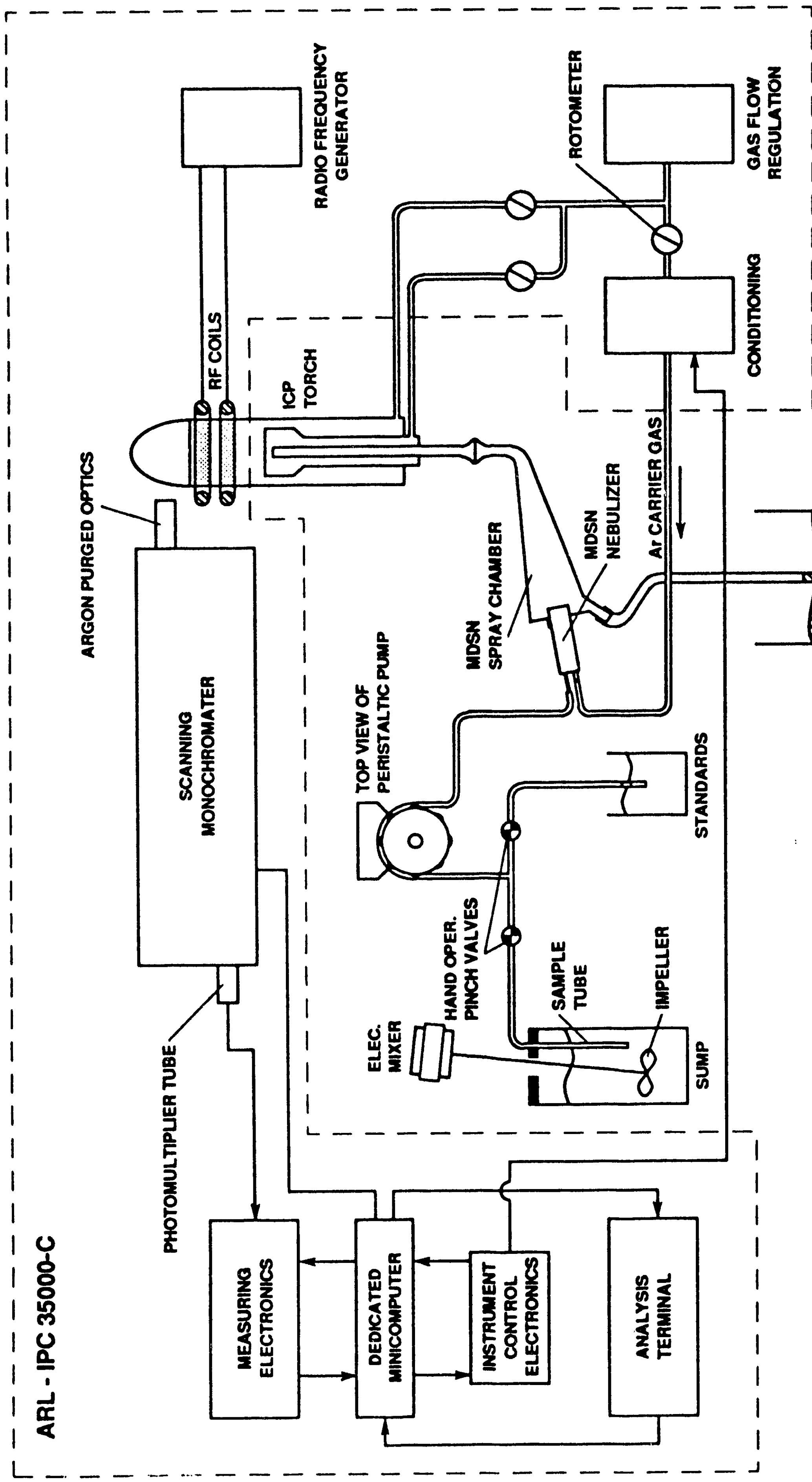
Cole Parmer Type CT21-18 motor
Cole Parmer Model 4651 controller/mixer

e Tygon Tubing.

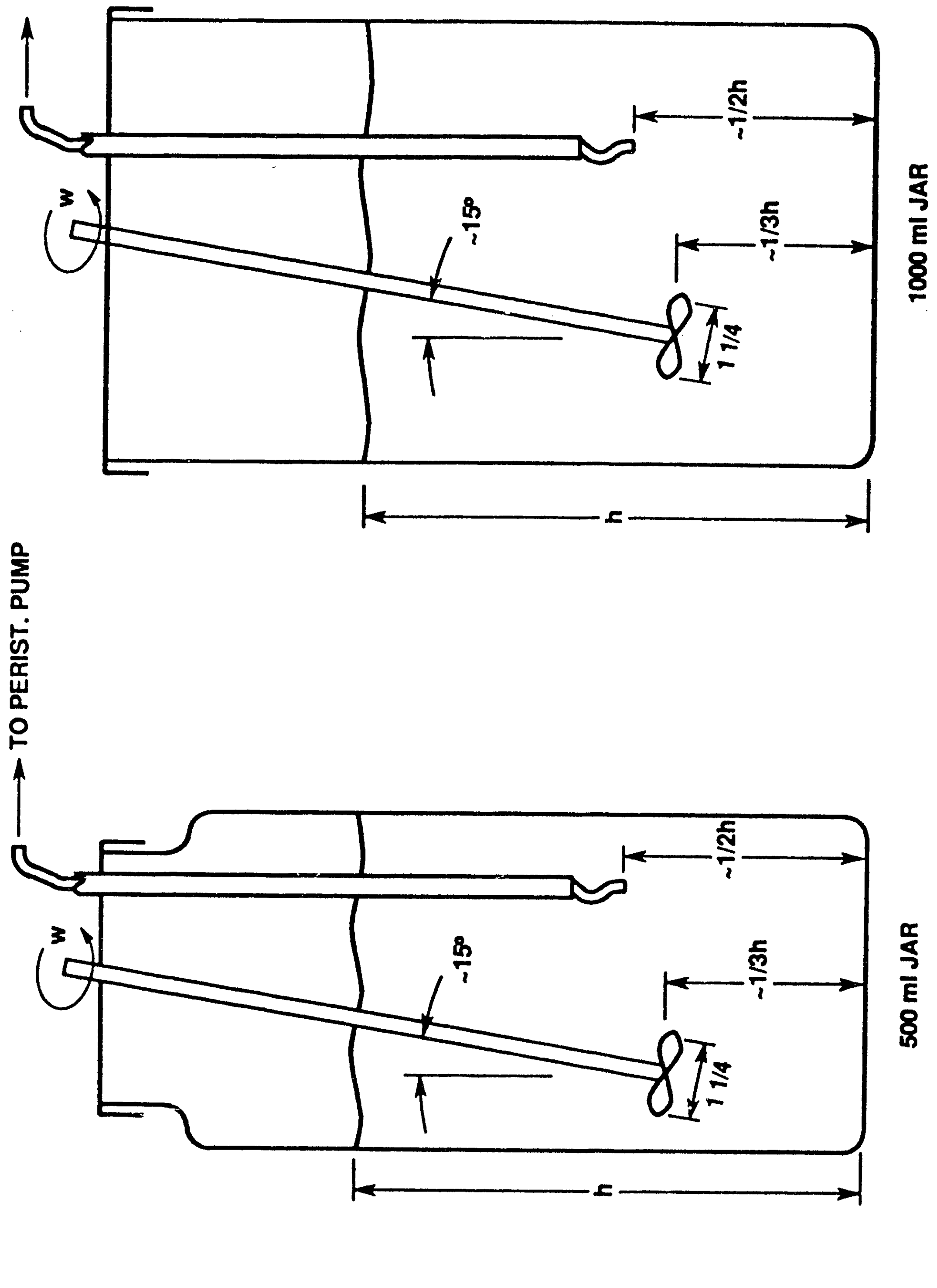
Gilson 0.8 cc/m (red tabs)

f Impellers.

3 blade 1.25" dia. (for stirring 500 ml container)
4 blade 1.75" dia. (for stirring 1000 ml container)



ARL - IPC 35000-C
MEASURING ELECTRONICS
DEDICATED MINICOMPUTER
INSTRUMENT CONTROL ELECTRONICS
ANALYSIS TERMINAL
PHOTOMULTIPLIER TUBE
SCANNING MONOCHROMATER
ARGON PURGED OPTICS
RF COILS
ICP TORCH
RADIO FREQUENCY GENERATOR
ROTOMETER
GAS FLOW REGULATION
CONDITIONING
DRAIN SUMP
Ar CARRIER GAS
MDSN NEBULIZER
MDSN SPRAY CHAMBER
TOP VIEW OF PERISTALTIC PUMP
STANDARDS
HAND OPER. PINCH VALVES
SAMPLE TUBE
IMPELLER
ELEC. MIXER
SUMP


TO PERIST. PUMP
w
~15°
1 1/4
~1/3h
~1/2h
h
1000 ml JAR
500 ml JAR

g Spring loaded laboratory pinch valves.

h Stopwatch

i Graduated Cylinder (0 - 10 cc)

3. Test Procedure

3.1 Prepare Standards

Primary standards shall be prepared for the purpose of calibrating the ICP. The primary standards should contain each element to be investigated in concentrations exceeding the maximum concentration expected in the coal slurries. Secondary standards shall also be prepared for the purpose of checking the calibration accuracy periodically during testing. The secondary standards shall contain lower concentrations (e.g. approximating the average of the concentration expected in the coal slurries) of each element than the primary standards. Since two different coal slurry types will be tested (an Upper Freeport and an Oklahoma bituminous), it is desirable to prepare two sets of standards:

Element	U.F.-Standard (PPM)		Okla-Standard (PPM)	
	Primary	Secondary	Primary	Secondary
S	50	20	100	50
Si	50	20	200	100
Al	50	20	100	50
Fe	50	20	100	50
Ca	10	5	50	20
Mg	5	2	10	5

3.2 Set-Up Equipment

Set up the equipment as depicted in figure 1. The following parameters are suggested based upon prior testing:

Q_{anal}= 2 - 4 ml/min

Q_{Ar} = as low as practical (approx. 0.3 l/min)

RF-Power 1.25 kW

Mixer - 200 RPM (max speed in low gear)
- angled slightly at approx 2/3 depth of fluid height

Sample Tube - to a depth of 1/2 fluid height

3.3 Shake-Down Testing.

Using a stop watch, a graduated cylinder and a beaker of water, set the peristaltic pump to pump at approx. 3 ml/min.

Since the quantity of field collected samples is limited, precaution must be taken to "tune" the system prior to consuming the samples. Two liter containers of "calibration" slurry has been provided for that purpose. The calibration slurries, FGU (Upper Freeport) and CGO (Oklahoma), contain 44 PPM S and 53 PPM S respectively based upon analyses done at B&W using a LECO analyzer. These concentrations include sulfur in suspended coal as well sulfur in solution (i.e. background). The ICP shall be calibrated using primary standards and the calibration samples analyzed. The ICP parameters defined in section 3.2 may be adjusted to provide better accuracy and repeatability.

With the parameters selected, the calibration slurries shall be analyzed in triplicate for S.

At the conclusion of the shakedown testing the peristaltic pump rate shall be checked and recorded. Small changes in the rate at which the pump operates is expected due to wear of the tygon tubing. Changes of as much as 10 % can be tolerated. If the rate changes by more than 10 %, the tygon tubing on the pump head shall be replaced.

3.4 Analysis of FGU Sample Slurries

3.4.1 ICP Calibration

Using a stop watch, a graduated cylinder and a beaker of water, set the peristaltic pump to pump at approx. 3 ml/min.

The ICP shall be calibrated using the appropriate primary standards. The results of the calibration shall be recorded on data sheet A. Be sure to not the value of Q_{Ar} since this is a critical parameter.

3.4.2 Analysis of Samples

Each of the FGU samples shall be analyzed for the six elements (S, Si, Al, Fe, Ca, Mg) in triplicate. After the third trial, the secondary standard shall be analyzed. The results of the slurry analysis and the secondary standards shall be recorded on data sheet B (use a separate data sheet for each slurry sample.

Record the value of Q_{Ar} and Reflected Power regularly. If the value of Q_{Ar} or Refl. Power change, it may be necessary to clean the nebulizer and spray chamber and recalibrate the system.

At the conclusion of the sample analysis, the peristaltic pump rate shall be checked and recorded.

At the conclusion of the slurry analysis, the slurry shall be allowed to settle and a small amount of water poured through a .45 micron filter into a clean sample container. This water shall be analyzed in duplicate for the same elements using standard ICP apparatus rather than the MDSN nebulizer. The concentrations of elements in the water shall be recorded and labeled "background".

3.5 Analysis of CGO Sample Slurries

The procedure described above for the 8 FGU samples shall be repeated for the 12 CGO slurries.

3.6 Analysis of Well Water and Clarified Water.

The sample slurries that were collected at the field site were created by adding clarified water at the CQ facility to dry coal. In addition, the B&W sampling system diluted the slurry further with well water from the site (in order to ensure a slurry concentration of less than 3 % solids). Although the water from each slurry sample is analyzed for background concentrations, it is of interest to determine the concentration of elements in the push water and well water for reference. Two samples of the well water and two samples of the clarified water have been provided for analysis. These samples should be analyzed for the six relevant elements either using the set-up prepared for slurry analysis or by the normal ICP procedures (i.e. without peristaltic pump and MDSN nebulizer).

4.0 Test Matrix

Table 1 lists the 8 FGU slurry samples and the 12 CGO slurry samples to be analyzed. The estimated concentration of the elements in each of the slurries, ignoring the background concentrations in the water, is also presented. The estimates are based upon the tests run at the Homer City Coal Lab on the individual samples for sulfur and the reference sample (average for all samples) for the other elements. It is noted that the Homer City Coal Lab filters the slurry prior to analysis and therefore reports the elemental concentration in the suspended solids only. For certain of the elements, the background concentrations in the water may significantly increase the estimated concentrations presented in Table 1.

TABLE 1 : TEST MATRIX

FILE ICPSAMP1.WK1
10/02/90

TEST SAMPLE ID	% SOLIDS	% ASH	S	Si	Al	Fe	Ca	K	Mg	Na	Ti	P
			ESTIMATED PPM ELEMENTS IN SLURRY									
FGU SC4 - 1	0.085	21.08	20	37	18	20	4.7	3.2	1.1	0.2	0.3	0.2
FGU SC4 - 2	0.097	20.71	23	42	21	23	5.3	3.7	1.3	0.2	0.3	0.2
FGU SC4 - 3	0.097	20.46	23	42	21	23	5.3	3.7	1.3	0.2	0.3	0.2
FGU SC4 - 4	0.083	21.47	21	36	18	20	4.6	3.2	1.1	0.2	0.2	0.2
FGU SC4 - 5	0.083	20.70	20	36	18	20	4.6	3.2	1.1	0.2	0.2	0.2
FGU SC4 - 6	0.090	20.32	23	39	20	22	5.0	3.4	1.2	0.2	0.3	0.2
FGU SC4 - 7	0.097	20.31	25	42	21	23	5.3	3.7	1.3	0.2	0.3	0.2
FGU SC4 - 8	0.092	20.22	23	40	20	22	5.0	3.5	1.2	0.2	0.3	0.2
CGO SC4 - 1	0.812	7.72	54	179	75	74	41.4	19.5	7.3	3.2	3.2	0.0
CGO SC4 - 2	0.780	8.20	53	172	73	71	39.8	18.7	7.0	3.1	3.1	0.0
CGO SC4 - 3	0.702	8.90	47	154	65	64	35.8	16.8	6.3	2.8	2.8	0.0
CGO SC4 - 4	0.667	9.45	44	147	62	61	34.0	16.0	6.0	2.7	2.7	0.0
CGO SC4 - 5	0.570	9.59	38	125	53	52	29.1	13.7	5.1	2.3	2.3	0.0
CGO SC4 - 6	0.570	9.91	40	125	53	52	29.1	13.7	5.1	2.3	2.3	0.0
CGO SC4 - 7	0.558	9.66	37	123	52	51	28.5	13.4	5.0	2.2	2.2	0.0
CGO SC4 - 8	0.570	9.91	37	125	53	52	29.1	13.7	5.1	2.3	2.3	0.0
CGO SC4 - 9	0.467	10.96	31	103	43	42	23.8	11.2	4.2	1.9	1.9	0.0
CGO SC4 -10	0.382	13.94	31	84	35	35	19.5	9.2	3.4	1.5	1.5	0.0
CGO SC4 -11	0.163	15.01	13	36	15	15	8.3	3.9	1.5	0.7	0.7	0.0
CGO SC4 -12	0.327	12.08	22	72	30	30	16.7	7.8	2.9	1.3	1.3	0.0
FGU CALIBR	0.05		44									
CGO CALIBR	0.289		53									
WELL WATER	0											

5.0 Data Sheets

The two data sheets which follow were prepared for the convenience of the ICP operator.

DOE SULFUR & ASH DATA SHEET A

DATE:__________ PAGE #:____

TIME:__________

Ar-FLOW RATE (l/min):________________________________

ICP POWER LEVEL:_____

PRIMARY STANDARDS:

ELEMENT	WAVELENGTH	INTENSITY	CONCENTR.
S			
Si			
Al			
Fe			
Ca			
Mg			

DOE SULFUR & ASH DATA SHEET B

DATE:__________ PAGE #:______

SAMPLE #:______________________, % SOLIDS:__________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----		
	S	SAMPLE	TRIAL 1	------					------
	Si	SAMPLE	TRIAL 1	------					------
	Al	SAMPLE	TRIAL 1	------					------
	Fe	SAMPLE	TRIAL 1	------					------
	Ca	SAMPLE	TRIAL 1	------					------
	Mg	SAMPLE	TRIAL 1	------					------
	S	SAMPLE	TRIAL 2	------					------
	Si	SAMPLE	TRIAL 2	------					------
	Al	SAMPLE	TRIAL 2	------					------
	Fe	SAMPLE	TRIAL 2	---					------
	Ca	SAMPLE	TRIAL 2	------					------
	Mg	SAMPLE	TRIAL 2	------					------
	S	SAMPLE	TRIAL 3	------					------
	Si	SAMPLE	TRIAL 3	------					------
	Al	SAMPLE	TRIAL 3	------					------
	Fe	SAMPLE	TRIAL 3	------					------
	Ca	SAMPLE	TRIAL 3	------					------
	Mg	SAMPLE	TRIAL 3	------					------
	S	STANDAR	------						------
	Si	STANDAR	------						------
	Al	STANDAR	------						------
	Fe	STANDAR	------						------
	Ca	STANDAR	------						------
	Mg	STANDAR	------						------
	---	-----	-----	-----	-----	-----	-----		

APPENDIX C

ALGORITHM FOR CONVERTING ICP-ELEMENT ANALYSIS TO % ASH

APPENDIX C

ALGORITHM FOR CONVERTING ICP-ELEMENT ANALYSIS TO % ASH

Algorithm for Converting ICP-Element Analysis to % Ash

Since the ICP is capable of measuring the element concentration in the coal, it is necessary to employ an algorithm to convert the elemental concentrations to % Ash (and thus to be able to compare to the % Ash determined by the Homer City Coal Lab in samples SC4' of test nos. 3 & 4). B&W has investigated the algorithm developed by SRI for the CONAC system under contract to EPRI (see reference 16, page 5-15):

$$W_{ASH} = 2.139W_{Si} + 1.889W_{Al} + 1.430W_{Fe} + 1.399W_{Ca} + 1.348W_{Na} + 1.205W_{K} + 1.668W_{Ti} + W_{MgO} + W_{SO3} \quad 1]$$

where: W = % weight of dry coal or, in the case of the oxides, % weight of dry ash.

The constants in equation [1] are the inverse of the gravimetric factors with the exception of the oxide terms MgO and SO_3. The appearance of these two oxide forms causes two computational complications. The first complication is that, of the sulfur measured in the dry coal, only a small portion stays in the ash. Therefore the ICP sulfur measurement, as a % of the dry coal, alone is not sufficient to determine W_{SO3}. The amount of SO_3 retained in the ash (as determined by ASTM D-3174) has been found to be related to the amount of calcium in (or alkalinity of) the ash[3,4]. For lignite, relationships between the sulfur and calcium in the coal are sometimes used to estimate W_{SO3}. For bituminous and subbituminous coals, the amount of sulfur in the ash is, however, negligible and may be ignored when computing the % ash in coal.

The second complication is the need to know the value of W_{ash} prior to computing W_{MgO}, where the following equation relates the MgO content of the ash to the measured Mg in the coal:

$$W_{MgO} = (100\ W_{Mg})/(W_{ash}\ GF) \quad [2]$$

where: W_{MgO} = % weight of MgO in ash
W_{Mg} = % weight of Mg in coal
W_{ash} = % weight of ash in coal
GF = Gravimetric Factor
= (Mol.Wt. of Mg)/(Mol.Wt. of MgO)

For coals in which MgO is a small portion of the total ash, W_{ash} used in the above equation may be approximated by W_{ash} calculated using all elements other than Mg. If more accuracy is desired, the calculation may be repeated a second time with the recalculated value of W_{ash}.

This particular algorithm, eqn. [1] was applied to the three coals tested in the screening test phase of the current contract. The algorithm was used twice - once using all terms except W_{SO3} and the second using only the first three terms (i.e. W_{Si}, W_{Al}, and W_{Fe}).

APPENDIX D

DATA SHEETS ON COAL USED DURING FIELD TESTING

...a 29
...mer City, PA 15748
..12-479-6011

UPPER FREEPORT DATA SHEET

Penelec / GPU

Certificate of Analysis

Pennsylvania Electric Company
Homer City Laboratory

Description:
HELEN UPPER FREEPORT
RUN #89051702
41001 CRUSHED TO 3/8" X 0
TOTAL SAMPLE

Lab No.: 891100066
From: EPRI-CQDC
Sampled: / /
Gross Wt.: 256.6000 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
PROXIMATE		
% Total Moisture	3.58	
% Ash	42.27	43.84
% Volatile (non-sparking)	18.32	19.00
% Fixed Carbon (by difference)	35.83	37.16
ULTIMATE		
% Carbon	45.66	47.36
% Hydrogen	2.86	2.97
% Nitrogen	0.50	0.52
% Total Sulfur	3.83	3.97
% Ash	42.27	43.84
% Oxygen (by difference)	1.29	1.34
Sulfur Forms		
% Pyritic Sulfur	2.93	3.04
% Sulfate Sulfur	0.05	0.05
% Organic Sulfur	0.85	0.88
Calorific Value (BTU/lb)	7977	8273
% Chlorine	0.09	0.10
% Equilibrium Moisture	2.00	
% Lithium Oxide (in ash)	0.02	0.03

Major Elements in Ash	
% SiO2	52.70
% Al2O3	23.30
% Fe2O3	14.17
% CaO	1.59
% MgO	1.21
% Na2O	0.36
% K2O	3.04
% TiO2	1.08
% MnO2	0.04
% P2O5	0.55
% SO3	0.94
TOTAL %	98.98

Grindability 72

AS RECEIVED values for Hydrogen and Oxygen do not include H and Ox in sample moisture

Grindability subsample analyzed at 0.68 % Total Moisture.

Approved: [signature] Date: DEC 29 1989

D-1

OKLAHOMA DATA SHEET

QUESTIONNAIRE ON COAL SOURCE

MINE LOCATION

STATE: OKLAHOMA

COUNTY: CRAIG, NOWATA & ROGERS

SEAM

NAME: CROWEBURG — DIP: ________ (degrees)

NUMBER: ________ — LITHOLOGY: ________ (band, inches)

THICKNESS: 13 (inches)

METHOD OF MINING: Strip (continuous, strip, auger, longwall, conventional, shortwall, etc.)

TYPES OF EQUIPMENT: Dragline and Dozers (continuous miner, shearer, etc.)

MODE OF HANDLING: Truck Haulage & Rail (conveyors, skip, truck haulage, etc.)

BREAKING & CRUSHING:

BREAKER TYPE: McNally Rotary Breaker (None, Stamler, Bradford, etc.)

CRUSHER TYPE: None (None, single, double, quad-roll, etc.)

PRE-PREPARATION:

NONE (None, picking, washing)

100 % (Yield, feed ash, product ash, refuse ash, etc.)

PRE-SCREENING:

SCREEN TYPE: Grizzly (Grizzly (opening size), scalper, etc.)

SIZE:

AS MINED: ________ (12" x 0, 6" x 0, 3" X), etc.)

AFTER BREAKER: 2" X 0 (6" x 0, 2" x 0, etc.)

AFTER CRUSHER: ________ (3" x 0, 2" x 0, etc.)

AFTER PRE-SCREENING: ________ (3" x 0, 2" x 3/8", 1" x 1/4", etc.)

AFTER PRE-PREPARATION: ________ (3" x 2, 2" x 1/2", etc.)

TYPICAL ANALYSIS
Analytical Services Department OKLAHOMA DATA SHEET

Mine or Prospect: ROGERS COUNTY NO. 2 Seam: SEQUOYAH (Croweburg)
Basis: RAW State: OKLAHOMA
Date: 08/01/88 Preparer: W. B. EMKE Approver: J. H. ADDINGTON

PROXIMATE ANALYSIS	(AS RECEIVED)	(DRY)
Moisture	11.3	
Ash	12.6	14.0
Volatile Matter	28.7	32.4
Fixed Carbon	47.4	53.6
BTU	[illegible]	12579
Sulfur	0.53	0.60
MAF BTU	14662	
Lb. SO2 / M BTU	0.9	

ULTIMATE ANALYSIS (DRY BASIS)	
Carbon	71.4
Hydrogen	4.6
Nitrogen	1.5
Chlorine	0.15
Sulfur	0.60
Ash	14.0
Oxygen	7.75

SULFUR FORMS (DRY BASIS)	
Pyritic Sulfur	0.15
Sulfate Sulfur	0.02
Organic Sulfur	0.43

WATER SOLUBLE ALKALIES (DRY BASIS)	
Sodium Oxide (Na2O)	0.010
Potassium Oxide (K2O)	0.004

EQUILIBRIUM MOISTURE	8.3
FREE SWELLING INDEX	3.5
HARDGROVE GRINDABILITY INDEX	62

ASH FUSION	
Reducing Atmosphere	
Initial Deformation Temp, F	2160
Softening Temp, F(H=W)	2200
Hemispherical Temp, F(H=1/2 W)	2215
Fluid Temp, F	2255
Oxidizing Atmosphere	
Initial Deformation Temp, F	2180
Softening Temp, F(H=W)	2200
Hemispherical Temp, F(H=1/2 W)	2215
Fluid Temp, F	2290

ANALYSIS OF ASH (IGNITED BASIS)	
Phosphorous Pentoxide (P2O5)	0.2
Silica (SiO2)	38.1
Ferric Oxide (Fe2O3)	8.2
Alumina (Al2O3)	14.9
Titania (TiO2)	0.7
Lime (CaO)	25.1
Magnesia (MgO)	1.7
Sulfur Trioxide (SO3)	8.0
Potassium Oxide (K2O)	2.14
Sodium Oxide (Na2O)	0.35
Strontium Oxide (SrO)	0.03
Barium Oxide (BaO)	0.04
Manganese Dioxide (MnO2)	0.34

ALKALIES AS Na2O	0.27
BASE/ACID RATIO	0.70
SILICA VALUE	52.12
SLAG VISCOSITY T250	2110

All analyses are subject to revision due to additional coring, conditions specified in the coal supply agreement, actual operating conditions at time of mining, type of preparation at time of mining, or federal and state regulations. Analysis intended for informational purposes only.

Source of Information : PROXIMATE ANALYSIS BASED ON ANALYSIS OF 123 CORES WITH .5" EXTRANEOUS. REMAINDER OF ANALYSIS BASED ON CORE COMPOSITE SAMPLES.

TOTAL P.03

APPENDIX E

HOMER CITY COAL LAB REPORTS

CQ Inc.
One Quality Center
P.O. Box 280
Homer City, PA 15748-0280

Phone 412•479•3503
FAX 412•479•4181

CQ Inc.

October 1, 1990

Mr. Mike Matlito
Babcock & Wilcox
1562 Beeson Street
Alliance, Ohio 44601-2196

Dear Mike:

Here is a complete set of laboratory analysis for your field test conducted at our facility for testing the sampling preparation and delivery system for your low-cost ash and sulfur analyzer. These analysis were performed by Homer City Coal Laboratory.

Enclosed is the sampling analysis for the following tests:

- Test No. FEED-NOGR-UF
  - Sample No. REFERENCE
  - Sample No. SQ3-1
- Test No. FEED-GR-UF
  - Sample No. REFERENCE
  - Sample No. SC4'-1 thru SC4'-8
- Test No. CONC-GR-OK
  - Sample No. REFERENCE
  - Sample No. SC4'-1 thru SC4'-12
- Test No. FEED-NOGR-OK
  - Sample No. REFERENCE
  - ST1-1
  - SQ3-1

This should complete all the analysis results for your project. If you have any question please call.

Sincerely:

Doug McCollough

Douglas E. McCollough

Enclosures

August 2· 1990

:ox 29
I... ..er City, PA 15748
412-479-9011

Penelec / GPU

Certificate of Analysis

Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER #90072501
TEST NO. FEED-NO GR-UF
SAMPLE NO. REFERENCE
TOTAL SAMPLE

Lab No.: 900800004
From: CQ INC
Sampled: 07/30/90
Gross Wt.: 82.6000 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	1.19	18.04
% Total Sulfur	0.16	2.49
% Total Moisture	93.43	
% Lithium Oxide (in ash)	0.00	0.03

Major Elements in Ash	
% SiO_2	49.56
% Al_2O_3	21.41
% Fe_2O_3	17.37
% CaO	3.84
% MgO	1.16
% Na_2O	0.26
% K_2O	2.52
% TiO_2	0.45
% MnO_2	0.06
% P_2O_5	0.38
% SO_3	1.97
TOTAL %	98.98

David O... AUG 28 1990

...er City, PA 15748
412-479-9011

GPU

Certificate of Analysis

Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER #90072501
TEST NO. FEED-NO GR-UF
SAMPLE NO. SQ3-1
TOTAL SAMPLE

Lab No.: 900800006
From: CQ INC
Sampled: 07/30/90
Gross Wt.: 3.5808 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.10	16.14
% Total Sulfur	0.01	2.00
% Total Moisture	99.35	
% Lithium Oxide (in ash)	0.00	0.03

Major Elements in Ash

% SiO2	52.89
% Al2O3	23.77
% Fe2O3	15.47
% CaO	1.98
% MgO	1.20
% Na2O	0.07
% K2O	2.71
% TiO2	0.31
% MnO2	0.04
% P2O5	0.38
% SO3	1.22
TOTAL %	100.07

E-3

Approved: D M Gleason Date: AUG 28 1990

Pennsylvania Electric Company is a Member of the General Public Utilities System

August 28, 1990

P.O. Box 29
Homer City, PA 15748
412-479-9011

GPU

Certificate of Analysis

Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER #90072502
TEST NO. FEED-GR-UF
SAMPLE NO. REFERENCE
TOTAL SAMPLE

Lab No.: 900800005
From: CQ INC
Sampled: 07/30/90
Gross Wt.: 107.1000 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	1.21	18.92
% Total Sulfur	0.18	2.81
% Total Moisture	93.60	
% Lithium Oxide (in ash)	0.00	0.03

Major Elements in Ash	
% SiO_2	49.04
% Al_2O_3	21.70
% Fe_2O_3	18.18
% CaO	4.08
% MgO	1.15
% Na_2O	0.16
% K_2O	2.43
% TiO_2	0.29
% MnO_2	0.06
% P_2O_5	0.21
% SO_3	1.93
TOTAL %	99.23

E-4

Approved: D.M. Gleason Date: AUG 28 1990

... City, PA 15748
4..-479-9011

Penelec GPU

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Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER #90072502
TEST NO. FEED-GR-UF
SAMPLE NO. SC4* - 1
TOTAL SAMPLE

Lab No.: 900800007
From: CQ INC
Sampled: 07/30/90
Gross Wt.: 0.5188 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.11	21.08
% Total Sulfur	0.01	2.38
% Total Moisture	99.49	

Approved: Dm Glessner Date AUG 09 1990

August 9, 1990

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r City, PA 15748
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Certificate of Analysis

Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER #90072502
TEST NO. FEED-GR-UF
SAMPLE NO. SC4* - 2
TOTAL SAMPLE

Lab No.: 900800008
From: CQ INC
Sampled: 07/30/90
Gross Wt.: 0.8825 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.12	20.71
% Total Sulfur	0.01	2.43
% Total Moisture	99.42	

Approved: [signature] Date AUG 09 1990

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Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER #90072502
TEST NO. FEED-GR-UF
SAMPLE NO. SC4" - 3
TOTAL SAMPLE

Lab No.: 900800009
From: CQ INC
Sampled: 07/30/90
Gross Wt.: 0.6873 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.12	20.46
% Total Sulfur	0.01	2.37
% Total Moisture	99.42	

E-7

Approved: D M Glessner Date: AUG 09 1990

August 9, 1990

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Certificate of Analysis

Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER #90072502
TEST NO. FEED-GR-UF
SAMPLE NO. SC4" - 4
TOTAL SAMPLE

Lab No.: 900800010
From: CQ INC
Sampled: 07/30/90
Gross Wt.: 0.6939 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.11	21.47
% Total Sulfur	0.01	2.51
% Total Moisture	99.50	

Approved: DM Gleasney Date AUG 09 1990

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Homer City Laboratory

Lab No.: 900800011
From: CQ INC
Sampled: 07/30/90
Gross Wt.: 0.7979 Kg

Description:
B & W ANALYZER #90072502
TEST NO. FEED-GR-UF
SAMPLE NO. SC4" - 5
TOTAL SAMPLE

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.10	20.70
% Total Sulfur	0.01	2.45
% Total Moisture	99.50	

E-9

Approved: DM Glasney Date: AUG 09 1990

August 9, 1990

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...er City, PA 15748
...-479-9011

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Homer City Laboratory

Description:
B & W ANALYZER #90072502
TEST NO. FEED-GR-UF
SAMPLE NO. SC4" - 6
TOTAL SAMPLE

Lab No.: 900800012
From: CQ INC
Sampled: 07/30/90
Gross Wt.: 0.8117 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.11	20.32
% Total Sulfur	0.01	2.54
% Total Moisture	99.46	

E-10

Approved: [signature] Date: AUG 09 1990

...r City, PA 15748
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Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER #90072502
TEST NO. FEED-GR-UF
SAMPLE NO. SC4" - 7
TOTAL SAMPLE

Lab No.: 900800013
From: CQ INC
Sampled: 07/30/90
Gross Wt.: 0.8064 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.12	20.31
% Total Sulfur	0.01	2.56
% Total Moisture	99.42	

E-11

Approved: ____ Date: AUG 09 1990

August 9 1990

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Description:
B & W ANALYZER #90072502
TEST NO. FLED-GR-UF
SAMPLE NO. SC4* - 8
TOTAL SAMPLE

Lab No.: 900800014
From: CO INC
Sampled: 07/30/90
Gross Wt.: 0.8235 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.11	20.22
% Total Sulfur	0.01	2.55
% Total Moisture	99.45	

E-12

Approved: D.M. Gleason Date: AUG 09 1990

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Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER RUN #90072503
TEST NO. CONC-GR-OK
SAMPLE NO. REFERENCE
TOTAL SAMPLE

Lab No.: 900800037
From: CQ INC
Sampled: 08/01/90
Gross Wt.: 21.7000 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	1.83	9.16
% Total Sulfur	0.14	0.71
% Total Moisture	79.98	
% Lithium Oxide (in ash)	0.00	0.02

Major Elements in Ash	
% SiO2	51.50
% Al2O3	19.10
% Fe2O3	14.20
% CaO	7.78
% MgO	1.70
% Na2O	0.61
% K2O	3.15
% TiO2	0.77
% MnO2	0.15
% P2O5	0.05
% SO3	2.55
TOTAL %	101.57

E-13

NOTE: REF SAMPLE COLLECTED IN FIELD IN TWO SEPARATE CONTAINERS. AT TEST CONCLUSION, THE FIRST CONTAINER WAS POURED INTO THE SECOND. THE FIRST CONTAINER WAS THE RINSED TWICE WITH DISTILLED H_2O AND POURED INTO THE SECOND CONTAINER. A TOTAL OF 3.5 li of DISTILLED H_2O WAS ADDED.

∴ PRIOR TO ADDING 3.5 l H_2O, THE GROSS WT = 18.20 KG

TOTAL MOISTURE = $[(.7998)(21.7) - 3.5]/18.2 = .7613$

% SOLIDS = $(1 - .7613) \times 100\% = 23.87\%$

MJM 12-12-90

Approved: DM Gleason Date: SEP 14 1990

August 2? 1990

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Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER RUN #90072503
TEST NO. CONC-GR-OK
SAMPLE NO. SC4' - 1
TOTAL SAMPLE

Lab No.: 900800038
From: CQ INC
Sampled: 08/01/90
Gross Wt.: 0.7575 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.38	7.72
% Total Sulfur	0.03	0.66
% Total Moisture	95.13	

E-14

Approved: D.M. Gleason Date: AUG 22 1990

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Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER RUN #90072503
TEST NO. CONC-GR-OK
SAMPLE NO. SC4' - 2
TOTAL SAMPLE

Lab No.: 900800039
From: CQ INC
Sampled: 08/01/90
Gross Wt.: 0.6525 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.38	8.20
% Total Sulfur	0.03	0.68
% Total Moisture	95.32	

Approved: Dm Gillessey Date AUG 22 1990

August 2^ 1990

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Homer City Laboratory

Description:
B & W ANALYZER RUN #90072503
TEST NO. CONC-GR-OK
SAMPLE NO. SC4* - 3
TOTAL SAMPLE

Lab No.: 900800040
From: CQ INC
Sampled: 08/01/90
Gross Wt.: 0.7354 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.37	8.90
% Total Sulfur	0.03	0.67
% Total Moisture	95.79	

Approved: Dm Gleasney Date: AUG 22 1990

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Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER RUN #90072503
TEST NO. CONC-GR-OK
SAMPLE NO. SC4" - 4
TOTAL SAMPLE

Lab No.: 900800041
From: CQ INC
Sampled: 08/01/90
Gross Wt.: 0.7104 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.38	9.45
% Total Sulfur	0.03	0.66
% Total Moisture	96.00	

Approved: [signature] Date: AUG 22 1990

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Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER RUN #90072503
TEST NO. CONC-GR-OK
SAMPLE NO. SC4• - 5
TOTAL SAMPLE

Lab No.: 900800042
From: CQ INC
Sampled: 08/01/90
Gross Wt.: 0.6583 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.33	9.59
% Total Sulfur	0.02	0.66
% Total Moisture	96.58	

August 22, 1990

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Description:
B & W ANALYZER RUN #90072503
TEST NO. CONC-GR-OK
SAMPLE NO. SC4* - 6
TOTAL SAMPLE

Lab No.: 900800043
From: CQ INC
Sampled: 08/01/90
Gross Wt.: 0.6187 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.34	9.91
% Total Sulfur	0.02	0.71
% Total Moisture	96.58	

E-19

Approved: Dm Gleasney Date: AUG 22 1990

Box 29
City, PA 15748
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GPU

Certificate of Analysis

Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER RUN #90072503
TEST NO. CONC-GR-OK
SAMPLE NO. SC4° - 7
TOTAL SAMPLE

Lab No.: 900800044
From: CO INC
Sampled: 08/01/90
Gross Wt.: 0.6985 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.32	9.66
% Total Sulfur	0.02	0.67
% Total Moisture	96.65	

E-20

Approved: Dm Gleason Date: AUG 22 1990

... City, PA 15748
412-479-9011

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Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER RUN #90072503
TEST NO. CONC-GR-OK
SAMPLE NO. SC4* - 8
TOTAL SAMPLE

Lab No.: 900800045
From: CQ INC
Sampled: 08/01/90
Gross Wt.: 0.6386 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.34	9.91
% Total Sulfur	0.02	0.65
% Total Moisture	96.58	

E-21

Approved: Dm Gleason Date: AUG 22 1990

August 22 1990

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r City, PA 15748
412-479-9011

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Certificate of Analysis

Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER RUN #90072503
TEST NO. CONC-GR-OK
SAMPLE NO. SC4* - 9
TOTAL SAMPLE

Lab No.: 900800046
From: CQ INC
Sampled: 08/01/90
Gross Wt.: 0.6829 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.31	10.96
% Total Sulfur	0.02	0.67
% Total Moisture	97.20	

E-22

D M Gleason ... AUG 22 1990

City, PA 15748
412-479-9011

Penelec GPU

Certificate of Analysis

Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER RUN #90072503
TEST NO. CONC-GR-OK
SAMPLE NO. SC4" - 10
TOTAL SAMPLE

Lab No.: 900800047
From: CQ INC
Sampled: 08/01/90
Gross Wt.: 0.7718 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.32	13.94
% Total Sulfur	0.02	0.80
% Total Moisture	97.71	

E-23

Approved: Dm Glessner Date AUG 22 1990

August 22, 1990

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4 -479-9011

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Certificate of Analysis

Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER RUN #90072503
TEST NO. CONC-GR-OK
SAMPLE NO. SC4* - 11
TOTAL SAMPLE

Lab No.: 900800048
From: CQ INC
Sampled: 08/01/90
Gross Wt.: 0.6411 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.15	15.01
% Total Sulfur	0.01	0.81
% Total Moisture	99.02	

Approved: [signature] Date: AUG 22 1990

...er City, PA 15748
412-479-9011

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Certificate of Analysis

Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER RUN #90072503
TEST NO. CONC-GR-OK
SAMPLE NO. SC4* - 12
TOTAL SAMPLE

Lab No.: 900800049
From: CQ INC
Sampled: 08/01/90
Gross Wt.: 0.7457 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.24	12.08
% Total Sulfur	0.01	0.68
% Total Moisture	98.04	

E-25

Approved: DM Gleason Date: AUG 22 1990

September 28, 1990

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. ner City, PA 15748
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Certificate of Analysis

Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER RUN #90072504
TEST NO. FEED-NOGR-OK
SAMPLE NO. REFERENCE
TOTAL SAMPLE

Lab No.: 900800170
From: CQ INC
Sampled: 08/07/90
Gross Wt.: 82.7000 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	3.09	38.44
% Total Sulfur	0.06	0.70
% Total Moisture	91.95	
% Lithium Oxide (in ash)	0.00	0.01

Major Elements in Ash

% SiO2	50.32
% Al2O3	13.92
% Fe2O3	17.52
% CaO	11.34
% MgO	0.91
% Na2O	0.52
% K2O	2.09
% TiO2	0.74
% MnO2	0.14
% P2O5	0.15
% SO3	1.11
TOTAL %	98.76

E-26

Approved: DM Glessner Date: SEP 28 1990

Box 29
Homer City, PA 15748
412-479-9011

Penelec GPU

Certificate of Analysis

Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER RUN #90072504
TEST NO. FEED-NOGR-OK
SAMPLE NO. ST1-1
TOTAL SAMPLE

Lab No.: 900800171
From: CQ INC
Sampled: 08/07/90
Gross Wt.: 3.3936 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.10	31.20
% Total Sulfur	0.00	0.51
% Total Moisture	99.67	
% Lithium Oxide (in ash)	0.00	0.04

Major Elements in Ash

% SiO2	53.21
% Al2O3	16.21
% Fe2O3	16.06
% CaO	8.56
% MgO	1.07
% Na2O	0.64
% K2O	2.28
% TiO2	0.98
% MnO2	0.14
% P2O5	0.05
% SO3	0.68
TOTAL %	99.90

E-27

Approved: Dm Gleason Date: SEP 14 1990

Penelec / GPU

Certificate of Analysis

Pennsylvania Electric Company
Homer City Laboratory

Description:
B & W ANALYZER RUN #90072504
TEST NO. FEED-NOGR-OK
SAMPLE NO. SQ3-1
TOTAL SAMPLE

Lab No.: 900800172
From: CQ INC
Sampled: 08/07/90
Gross Wt.: 8.1082 Kg

PARAMETER	AS RECEIVED	MOISTURE FREE
% Ash	0.15	34.53
% Total Sulfur	0.00	0.55
% Total Moisture	99.58	
% Lithium Oxide (in ash)	0.00	0.03

Major Elements in Ash	
% SiO_2	60.89
% Al_2O_3	19.27
% Fe_2O_3	8.36
% CaO	3.51
% MgO	1.22
% Na_2O	1.16
% K_2O	2.88
% TiO_2	1.53
% MnO_2	0.09
% P_2O_5	0.05
% SO_3	0.92
TOTAL %	99.90

Approved: DM Glessner Date: SEP 14 1990

THE BABCOCK & WILCOX COMPANY
ALLIANCE RESEARCH CENTER
LONG HAND MEMORANDUM

RC-3

To FILE

From M MALITO

File No. or Ref. 4554-07

Subj. TELECON : B+W (MALITO) - Q.C. INC (McCOLLOUGH) RESULTS OF QC'S REF. SAMPLES

Date 3 Dec 90

DOUG RELAYED THE FOLLOWING INFORMATION ON THE RESULTS OF Q.C. INC REFERENCE SAMPLES DURING TEST # 3 & 4:

AUG. 1 : Q.C - REF SAMPLE (CONCENTRATE)

% SOLIDS = 24.8 %
% ASH = 2.09 % AS REC
= 8.40 % MOIST. FREE

AUG 7 : Q.C. REF SAMPLE (FEED)

% SOLIDS = 8.00 %
% ASH = 3.09 % AS REC.
% ASH = 38.65 % MOIST. FREE

APPENDIX F

B&W CHEMISTRY LAB REPORTS

Babcock & Wilcox
a McDermott company

Research and Development Division
Alliance, Ohio 44601

RC-1 (Rev. 3-84)

To M. L. MALITO - STRUCTURAL MECHANICS SECTION, ARC	
From C. R. VOTAW - CHEMISTRY SECTION, ARC	
Cust. DEPARTMENT OF ENERGY	**File No.** ACG-91-4554-05
Subj. SULFUR & ASH ANALYZER COAL SLURRY ANALYSES	**Date** AUGUST 28, 1990

This letter to cover one customer and one subject only

Attached are the results for the analyses requested on the coal slurry samples submitted on 8/16/90.

C R Votaw
C. R. Votaw

Reviewed and Approved by H. L. [illegible] 8/29/90
Group Supervisor

let

Attachments

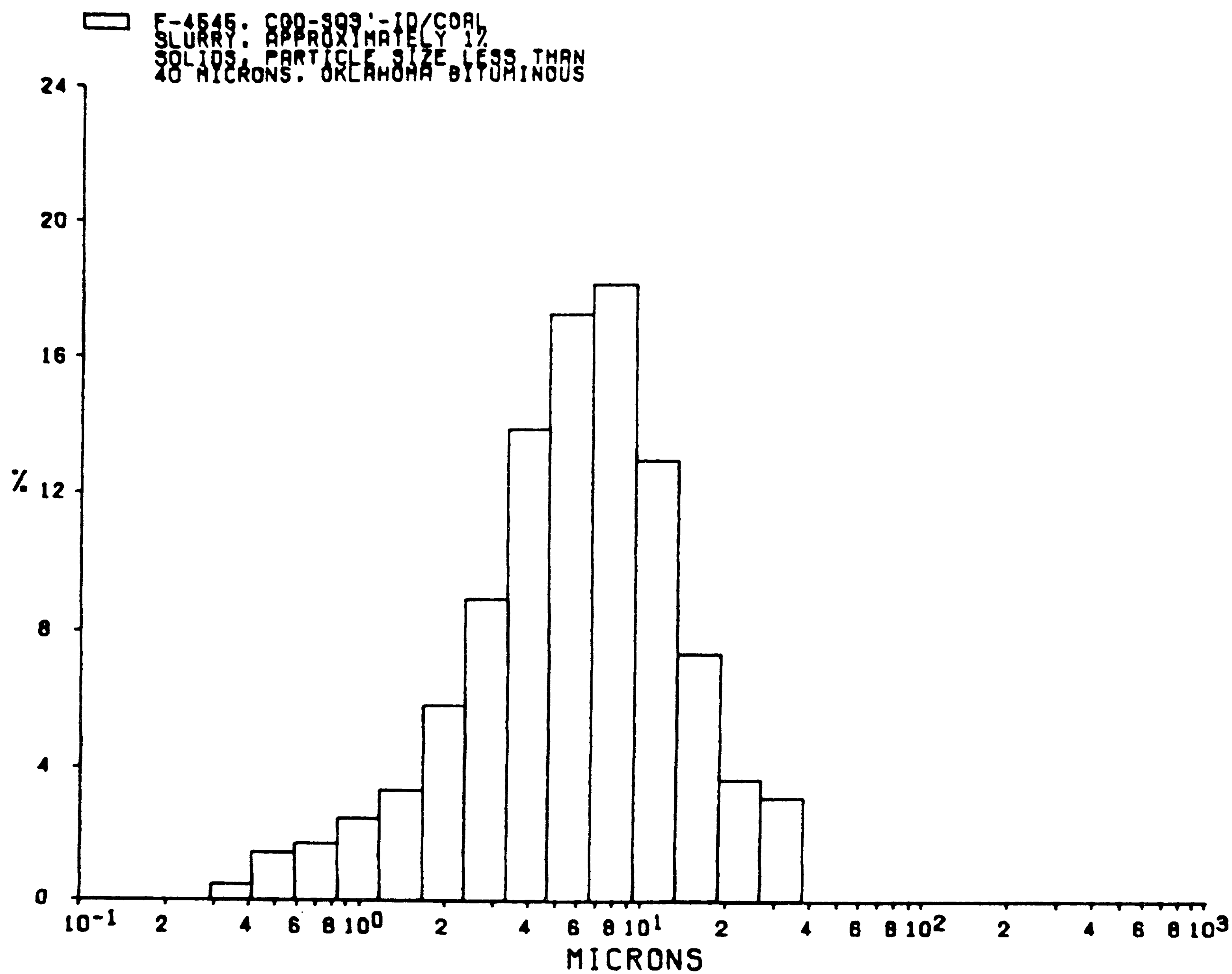
cc: R. F. DeVault
G. R. Taylor
ARC Library

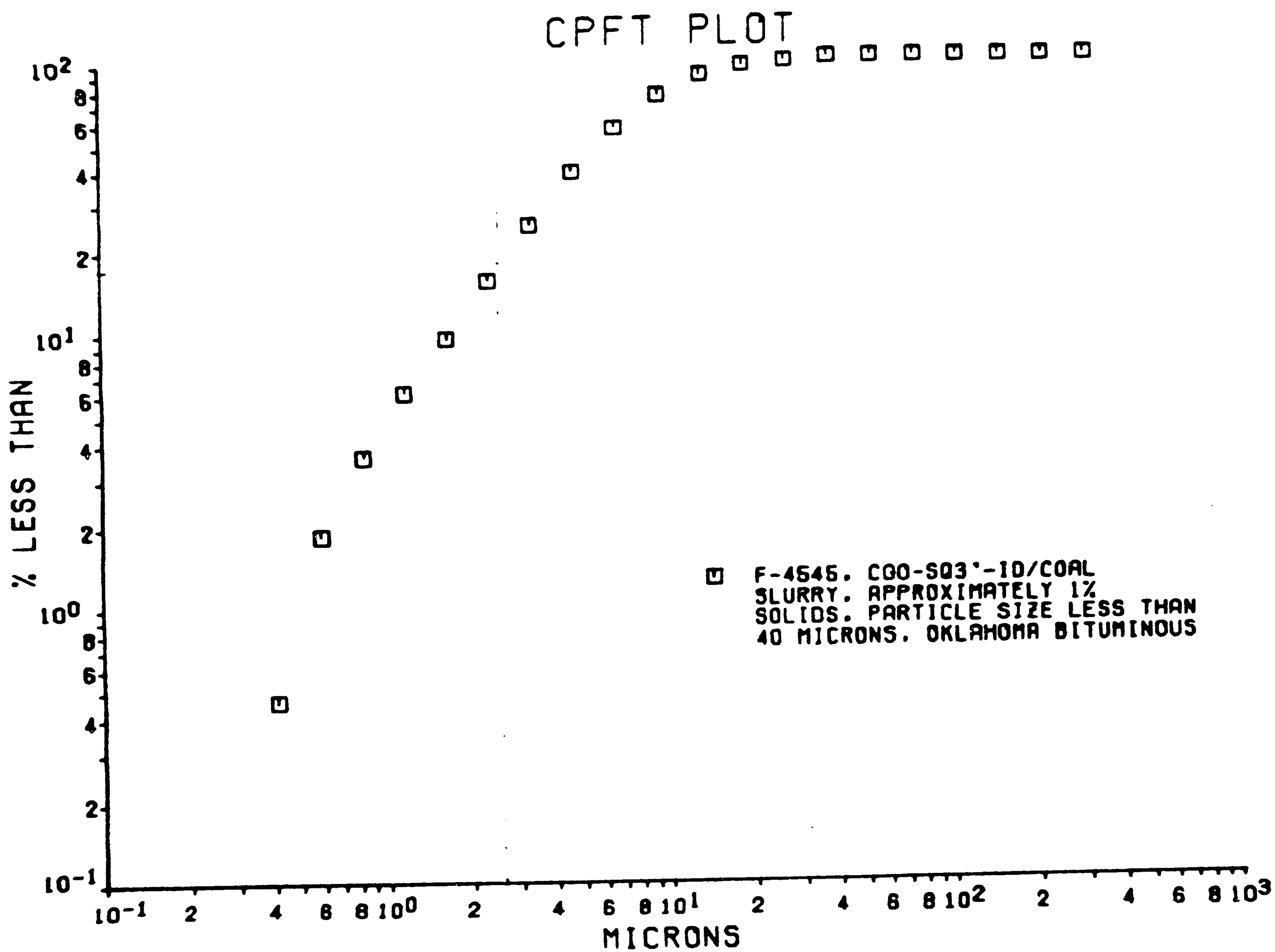
Sample No.	F-4545	F-4546
Description	CGO-SQ3'-ID Coal Slurry (~1% Solids, <40μ Particle Size, Olkahoma, Bituminous)	FGU-SQ3'-ID Coal Slurry (~1% Solids, <40μ Particle Size, Upper Freeport)
Total Moisture, %	97.86	99.76
Total Solids, %	2.14	0.24
Total Sulfur, Dry, % S	1.85	8.82
Total Sulfur, As Rec'd, % S	0.04	0.02

F-4545. COO-5Q3'-ID/COAL
SLURRY. APPROXIMATELY 1%
SOLIDS. PARTICLE SIZE LESS THAN
40 MICRONS. OKLAHOMA BITUMINOUS

MICRONS	% LESS	DIFF
300.00		
212.13		
150.00		
106.07		
75.00		
53.03		
37.50	100.00	3.11
26.52	96.89	3.67
18.75	93.22	7.34
13.26	85.88	12.85
9.38	73.03	18.03
6.63	55.00	17.16
4.69	37.84	13.76
3.31	24.08	8.88
2.34	15.20	5.84
1.66	9.36	3.34
1.17	6.02	2.47
0.83	3.56	1.70
0.59	1.86	1.40
0.41	0.46	0.46
0.29	0.00	0.00
0.21		
0.15		

CS(CAL SURF AREA)=1.68 M**2/CM**3
MMD(D43)=7.88 MICRONS
SMD(D32)=3.58 MICRONS

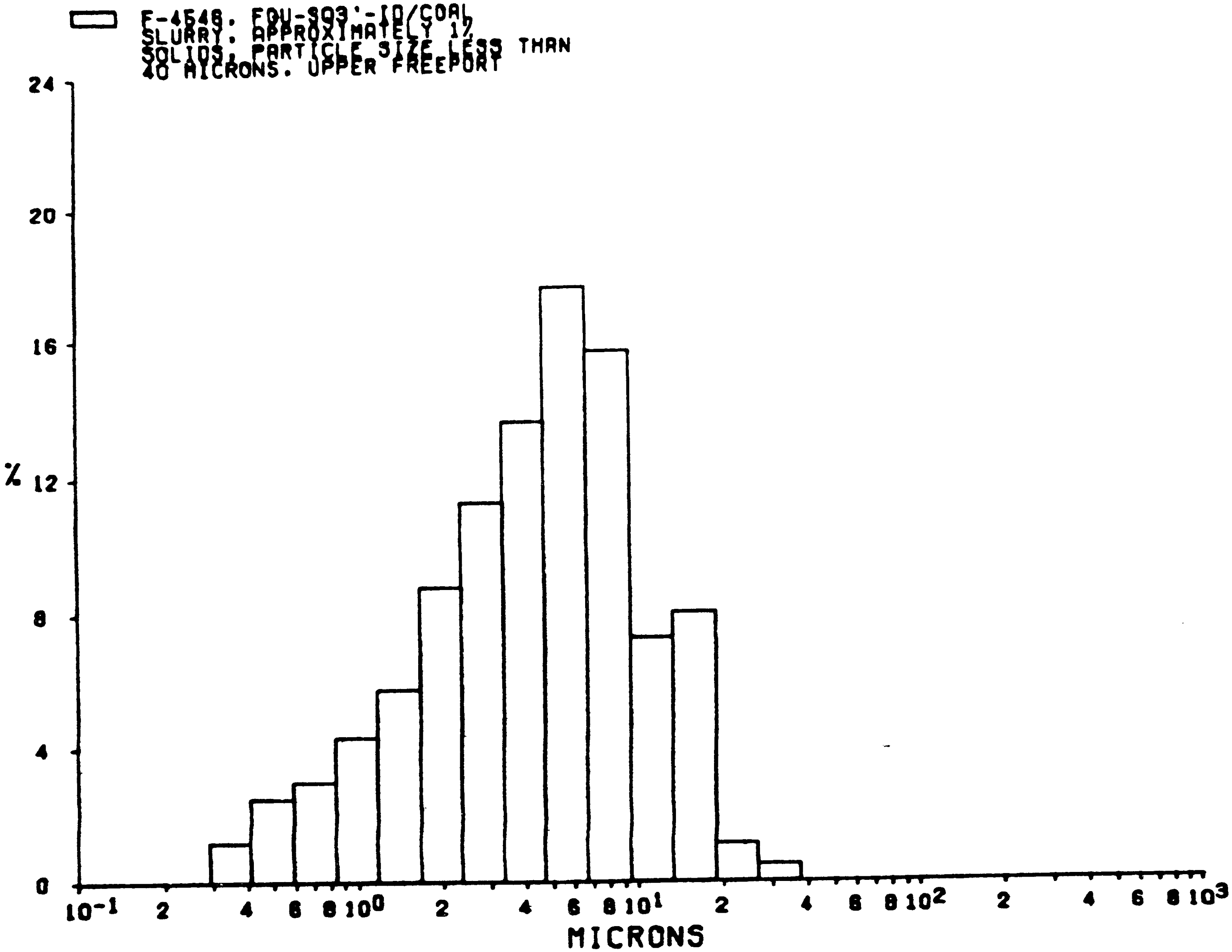

F-4545. COO-SO3'-ID/COAL SLURRY. APPROXIMATELY 1% SOLIDS. PARTICLE SIZE LESS THAN 40 MICRONS. OKLAHOMA BITUMINOUS
%
0
4
8
12
16
20
24
10^-1 2 4 6 8 10^0 2 4 6 8 10^1 2 4 6 8 10^2 2 4 6 8 10^3
MICRONS

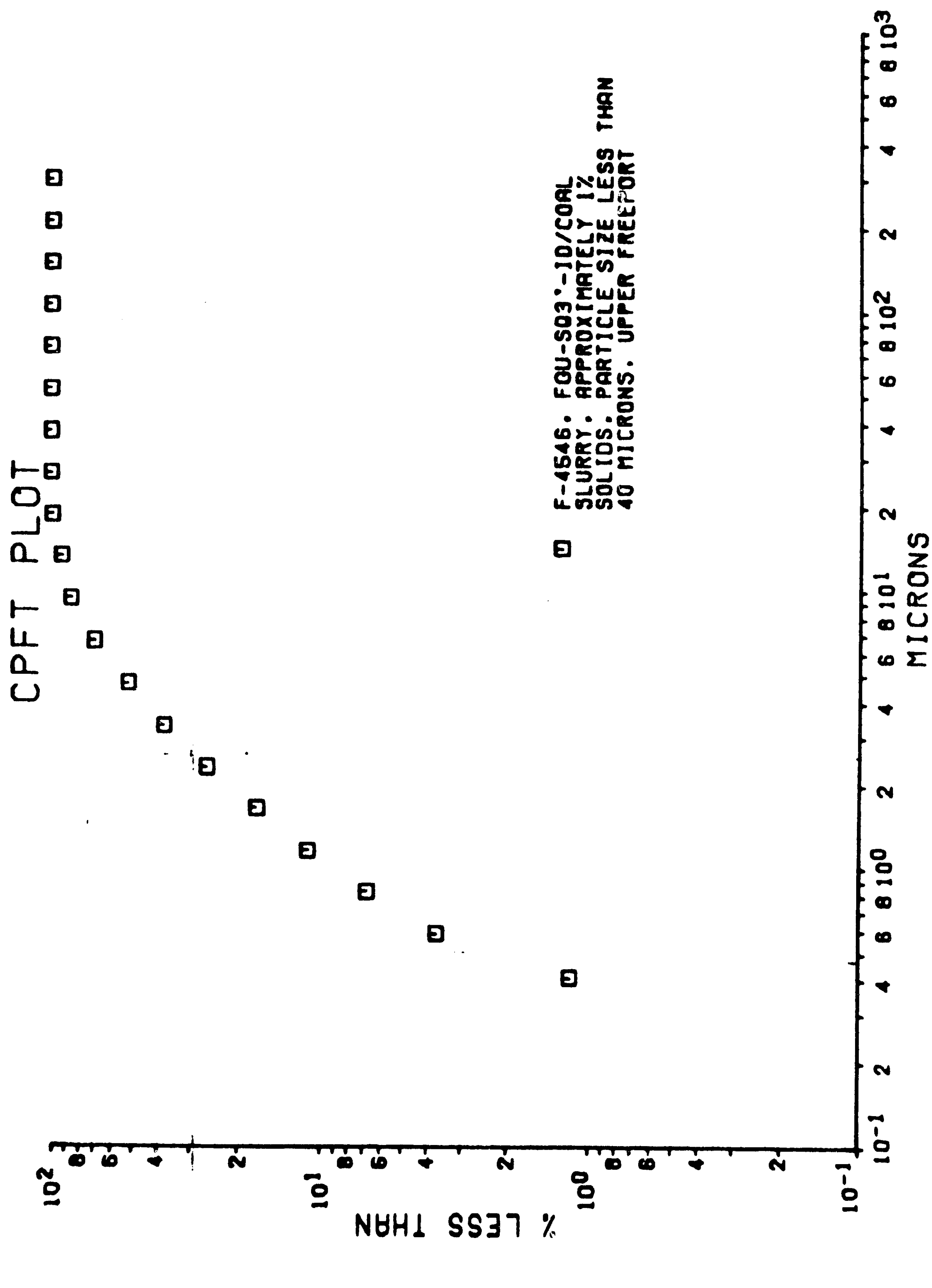

CPFT PLOT
% LESS THAN
MICRONS
10^{2}
8
6
4
2
10^{1}
10^{0}
10^{-1}
10^{3}
F-4545. CGO-SO3'-ID/COAL
SLURRY. APPROXIMATELY 1%
SOLIDS. PARTICLE SIZE LESS THAN
40 MICRONS. OKLAHOMA BITUMINOUS

F-4548. FGU-SO3'-IO/COAL
SLURRY. APPROXIMATELY 1%
SOLIDS. PARTICLE SIZE LESS THAN
40 MICRONS. UPPER FREEPORT

MICRONS	% LESS	DIFF
300.00		
212.13		
150.00		
106.07		
75.00		
53.03		
37.50	100.00	0.49
26.52	99.51	1.12
18.75	98.39	7.99
13.26	90.40	7.22
9.38	83.19	15.55
6.63	67.63	17.44
4.69	50.20	13.51
3.31	36.69	11.24
2.34	25.45	8.75
1.66	16.70	5.74
1.17	10.96	4.32
0.83	6.64	2.99
0.59	3.65	2.47
0.41	1.17	1.17
0.29	0.00	0.00
0.21		
0.15		

CS(CAL SURF AREA)=2.33 M**2/CM**3
MMD(D43)=5.93 MICRONS
SMD(D32)=2.57 MICRONS


F-4548: FDU-S03'-ID/COAL
SLURRY: APPROXIMATELY 1%
SOLIDS, PARTICLE SIZE LESS THAN
40 MICRONS. UPPER FREEPORT
%
0
4
8
12
16
20
24
10^{-1}
2
4
6
8
10^{0}
2
4
6
8
10^{1}
2
4
6
8
10^{2}
2
4
6
8
10^{3}
MICRONS


CPFT PLOT
% LESS THAN
MICRONS
F-4546. FOU-SO3'-ID/COAL
SLURRY. APPROXIMATELY 1%
SOLIDS. PARTICLE SIZE LESS THAN
40 MICRONS. UPPER FREEPORT

Babcock & Wilcox
a McDermott company

Research and Development Division
Alliance, Ohio 44601

RC-1 (Rev. 3-84)

To	M. L. MALITO - STRUCTURAL MECHANICS SECTION, ARC
From	C. R. VOTAW - CHEMISTRY SECTION, ARC
Cust. DEPARTMENT OF ENERGY	**File No.** ACG-91-4554-05
Subj. COAL SLURRY ANALYSIS	**Date** SEPTEMBER 6, 1990

This letter to cover one customer and one subject only

Attached are the results for the microtrac particle size distribution for the coal slurry submitted on 8/30/90. The solids content was 2.17% on the as received slurry.

C R Votaw

C. R. Votaw

Reviewed and Approved by ____________
Group Supervisor

let

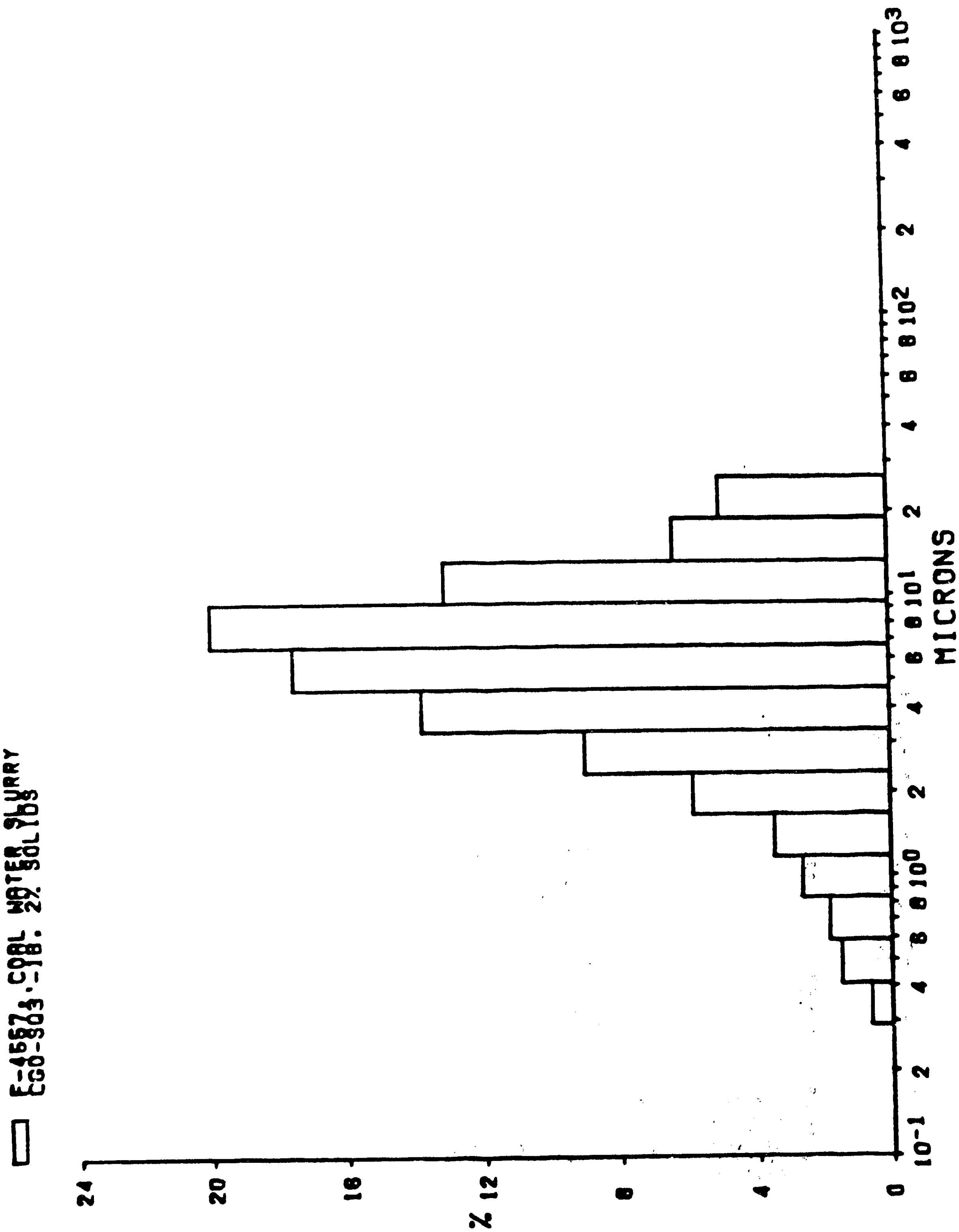
Attachment

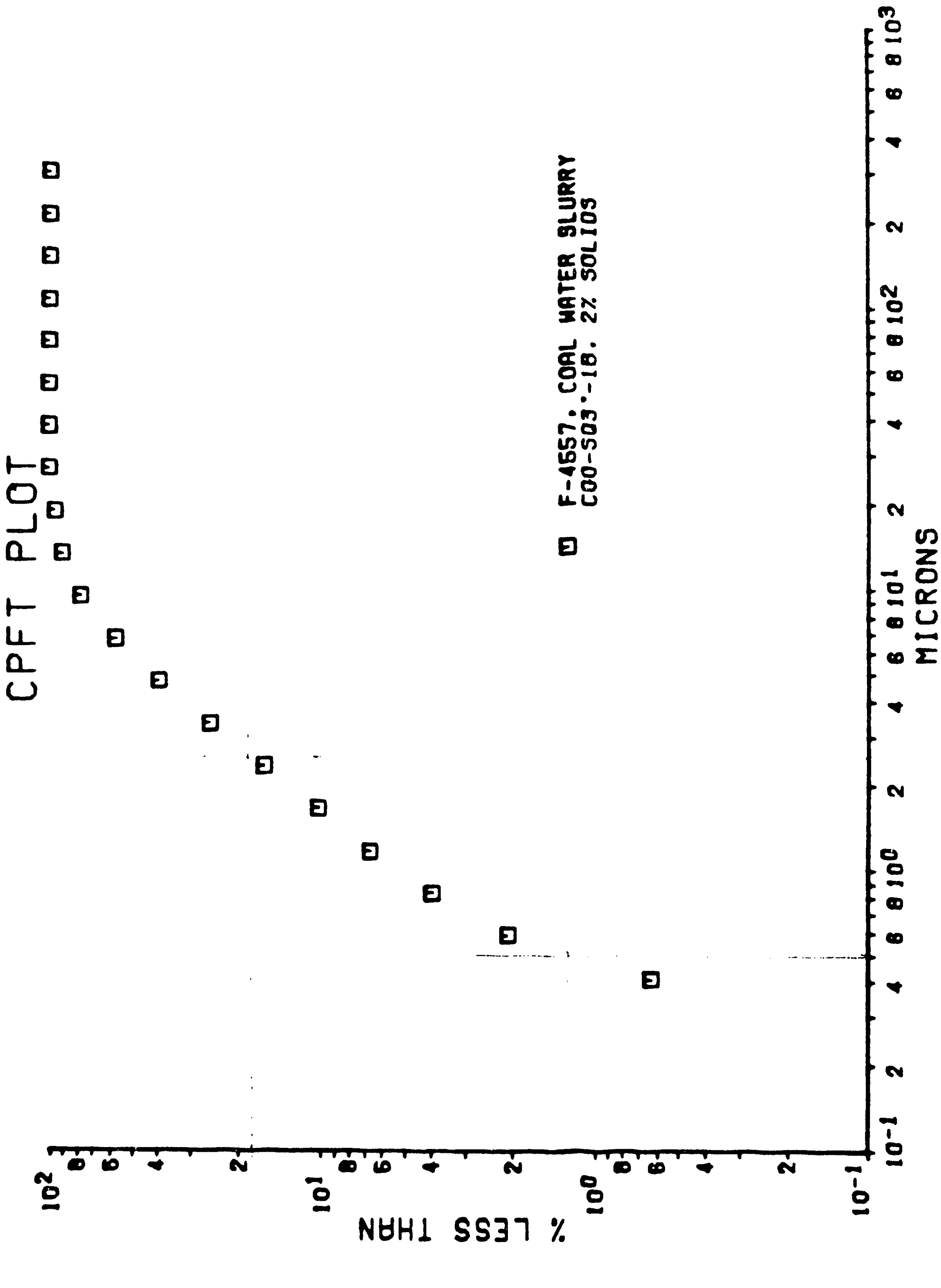
cc: R. F. DeVault
G. R. Taylor
ARC Library

F-4557. COAL WATER SLURRY
CGO-503'-18. 2% SOLIDS

MICRONS	% LESS	DIFF
300.00		
212.13		
150.00		
106.07		
75.00		
53.03		
37.50		
26.52	100.00	4.96
18.75	95.04	6.32
13.26	88.73	12.95
9.38	75.78	19.83
6.63	55.95	17.41
4.69	38.54	13.71
3.31	24.84	8.96
2.34	15.88	5.83
1.66	10.05	3.48
1.17	6.58	2.64
0.83	3.94	1.84
0.59	2.09	1.47
0.41	0.63	0.63
0.29	0.00	0.00
0.21		
0.15		

CS(CAL SURF AREA)=1.75 M**2/CM**3
MMD(D43)=7.19 MICRONS
SMD(D32)=3.42 MICRONS


COAL WATER SLURRY
MICRONS
%


CPFT PLOT
F-4557, COAL WATER SLURRY
C00-S03'-18. 2% SOLIDS
MICRONS
% LESS THAN

To

M. L. MALITO - STRUCTURAL MECHANICS SECTION, ARC

From

C. R. VOTAW - CHEMISTRY SECTION, ARC

Cust. DEPARTMENT OF ENERGY	**File No.** ACG-91-4554-05
Subj. COAL-WATER SLURRY ANALYSIS	**Date** SEPTEMBER 14, 1990

This letter to cover one customer and one subject only

Listed below are the results for the analysis of the coal water slurry sample submitted on 9/12/90.

Sample No.	F-4564
Description	Coal Water Slurry CGO-SQ3-1I
Total Solids, %	2.14
Total Sulfur, % S	
As Rec'd Basis	0.04
Dry Basis	1.83

C R Votaw

C. R. Votaw

Reviewed and Approved by
Group Supervisor

let

cc: R. F. DeVault
G. R. Taylor
ARC Library

Babcock & Wilcox
a McDermott company

Research and Development Division
Alliance, Ohio 44601

RC-1 (Rev. 3-

To

M. L. MALITO - STRUCTURAL MECHANICS SECTION, ARC

From

R. F. DEVAULT - CHEMISTRY SECTION, ARC

Cust. DOE/SULFUR & ASH ANALYZER PROJECT	**File No.** ACG-91-4554-05
Subj. ANALYSIS - PARTICLE SIZE	**Date** JANUARY 7, 1991

This letter to cover one customer and one subject only

Reported on the attached sheets are the results of Microtrac R particle size analysis on one (1) sample submitted to the laboratory on December 19, 1990.

R. F. DeVault

R. F. DeVault

Reviewed and Approved by G. R. Taylor 1/7/91
Group Supervisor

let

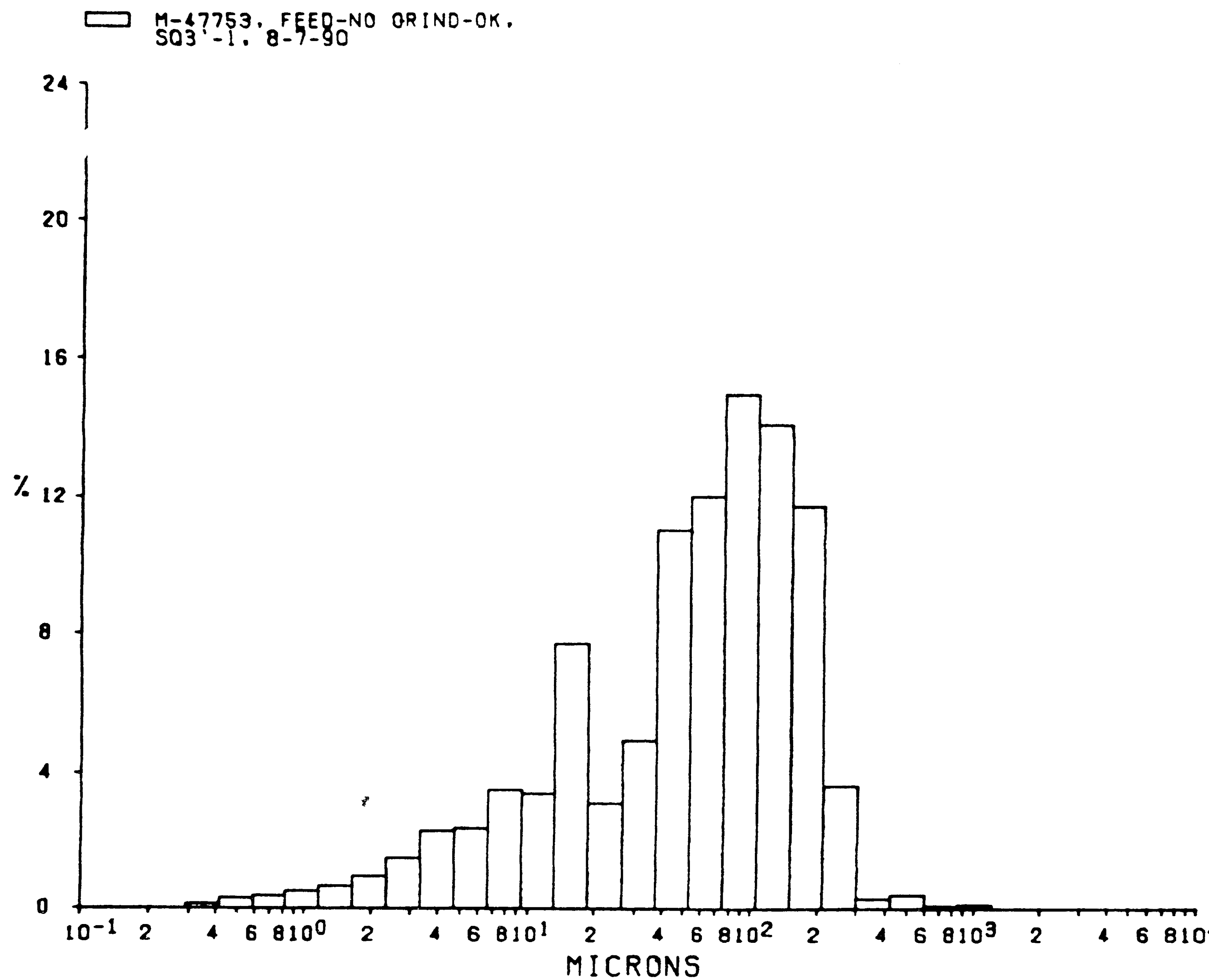
Attachments

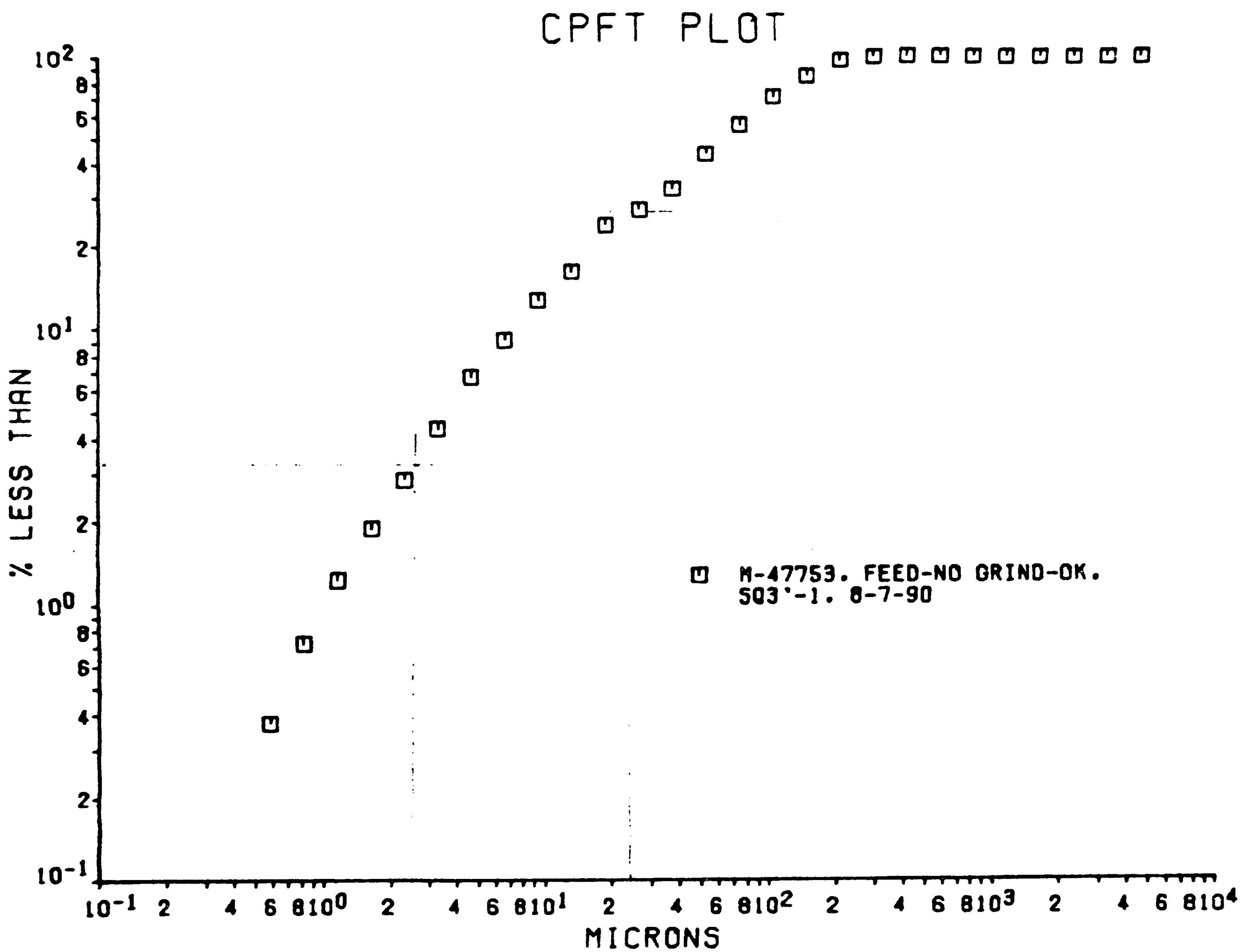
cc: G. R. Taylor
ARC Library

M-47753. FEED-NO GRIND-OK.
SO3'-1. 8-7-90

MICRONS	% LESS	DIFF
4800.00		
3394.11		
2400.00		
1697.06		
1200.00	100.00	0.11
848.53	99.89	0.09
600.00	99.80	0.41
424.26	99.39	0.29
300.00	99.10	3.62
212.13	95.48	11.70
150.00	83.78	14.07
106.07	69.71	14.93
75.00	54.77	11.99
53.03	42.78	11.03
37.50	31.75	4.96
26.52	26.80	3.13
18.75	23.67	7.71
13.26	15.96	3.43
9.38	12.53	3.52
6.63	9.01	2.38
4.69	6.63	2.31
3.31	4.32	1.49
2.34	2.83	0.94
1.66	1.89	0.66
1.17	1.23	0.51
0.83	0.72	0.35
0.59	0.38	0.29
0.41	0.09	0.09
0.29	0.00	0.00
0.21		
0.15		

CS(CAL SURF AREA)=0.40 M**2/CM**3
MMD(D43)=84.11 MICRONS
SMD(D32)=15.18 MICRONS


M-47753, FEED-NO GRIND-OK,
SQ3'-1, 8-7-90
%
24
20
16
12
8
4
0
10-1 2 4 6 8 10^0 2 4 6 8 10^1 2 4 6 8 10^2 2 4 6 8 10^3 2 4 6 8 10^4
MICRONS


CPFT PLOT
% LESS THAN
MICRONS
M-47753. FEED-NO GRIND-OK.
SO3'-1. 8-7-90

Babcock&Wilcox Research and Development Division
a McDermott company Alliance, Ohio 44601

RC-1 (Rev. 3-8

To

M. L. MALITO - STRUCTURAL MECHANICS, ARC

om

G. R. TAYLOR - CHEMISTRY SECTION, ARC

Cust.	File No.
D.O.E.	ACG-91-4554-06
Subj.	**Date**
ANALYSES - COAL WATER SLURRIES	JANUARY 15, 1991

This letter to cover one customer and one subject only

Attached are results obtained on two coal water slurry samples your submitted.

This confirms a previous verbal report.

G. R. Taylor

Reviewed and Approved by Section Manager 1-17-91

let

Attachment

cc: M. L. Diehl
P. R. Schliffka
C. R. Votaw
ARC Library

Sample No.	F-4630	F-4631
Description	Coal Water Slurry CGO-SQ3'-1A	Coal Water Slurry FGU-SQ3'-1G
Suspended Solids		
Ash, %	8.79	18.70
Total Sulfur, % S	0.55	0.82
Filtrate, (by ICP)		
Silicon, ppm Si	1.4	2.3
Aluminum, ppm Al	1.6	1.8
Iron, ppm Fe	<0.5	0.94
Calcium, ppm Ca	206	124
Magnesium, ppm Mg	41.9	29.6
Sulfur, ppm S	361	280

Comment: Suspended solids are the material remaining on a 0.45 μm filter. The solids were dried at 225°F.

Babcock & Wilcox Research and Development Division
a McDermott company Alliance, Ohio 44601 RC-1 (Rev. 3-8

To	M. L. MALITO - STRUCTURAL MECHANICS SECTION, ARC		
From	C. R. VOTAW - CHEMISTRY SECTION, ARC		
Cust.	D.O.E.	File No.	ACG-91-4554-06
Subj.	COAL WATER SLURRY ANALYSIS	Date	FEBRUARY 7, 1991

This letter to cover one customer and one subject only

Listed below are the results for the analysis of (2) two coal water slurry samples submitted on 2/6/91.

Sample No.	F-4658	F-4659
Description	Coal Water Slurry FGU-SQ3'-1E	Coal Water Slurry CGO-SQ3'-1E
Suspended Solids, %	0.18	2.14
Total Sulfur, % S (On The Suspended Solids)	0.67	0.50

C R Votaw

C. R. Votaw

Reviewed and Approved by ______ 2-7-91
Group Supervisor

let

cc: R. F. DeVault
G. R. Taylor
ARC Library

Babcock & Wilcox Research and Development Division
a McDermott company Alliance, Ohio 44601 RC-1 (Rev. 3-84)

To

M. L. MALITO - STRUCTURAL MECHANICS SECTION, ARC

From

C. R. VOTAW - CHEMISTRY SECTION, ARC

Cust.	**File No.**
D.O.E.	ACG-91-4554-06
Subj.	**Date**
COAL WATER SLURRY ANALYSIS	FEBRUARY 28, 1991

This letter to cover one customer and one subject only

Listed below are the results for the analysis of the two coal water slurry samples submitted on 2/22/91. The whole sample received was filtered to get the suspended solids per your request.

Sample No.	F-4666	F-4667
Description	Coal Water Slurry CGO-SQ3'-1H	Coal Water Slurry FGU-SQ3'-1H
Suspended Solids, %	2.04	0.18
Total Sulfur, %S *	0.48	0.69
Ash, % *	8.64	18.82

* On the dry suspended solids using a 0.45μ milliapore filter to collect suspended solids.

C R Votaw
C. R. Votaw

Reviewed and Approved by ______ 3/1/91
Group Supervisor

let

cc: R. F. DeVault
G. R. Taylor
ARC Library

Gould Energy 30 Commerce Avenue Thornwood New York 10594 914 769-7900
Warner Laboratories Division Gobbler Road P.O. Box 544 Cresson Pennsylvania 16630 814 886-7400
Warner Laboratories of West Virginia Division Route 50 East P.O. Box 9 Bridgeport West Virginia 26330 304 842-7443
Fuel Engineering Division 30 Commerce Avenue Thornwood New York 10594 914 769-7900
St. Louis Energy Division 11591 Page Service Drive St. Louis Missouri 63146 314 432-5454
Weighing and Control Services, Inc. P.O. Box 1460 Brandon Florida 33511 813 681-5733

WARNER LABORATORIES DIVISION

EPRI/CQDC
P.O. BOX 98
HOMER CITY, PA. 15748

DATE: 05-31-88
WARNER NO. S64801

DATE RECEIVED: 5/27/88
DATE/HOUR SAMPLED: 5/26/88 1:05 PM SAMPLED BY: D. McCOLLOUGH
DATE/HOUR ANALYZED: 5/27/88 1:30 PM ANALYZED BY: P.G.

SOURCE: CISTERN (SPRING)
POINT OF COLLECTION: OFFICE BLDG. (BASEMENT)
SAMPLE ID: #1A

DEPARTMENT OF ENVIRONMENTAL RESOURCES CERTIFICATION NO. 11-061

CERTIFICATE OF ANALYSIS

MICROBIOLOGICAL WATER ANALYSIS		METHOD NO.	PAGE REF.
TOTAL COLIFORM		<908A>	<872>
PRESUMPTIVE TEST (Lauryl Tryptose Broth)			
24 hour incubation at 35 C	positive tubes		
5 tubes 10.0ml	0		
48 hour incubation at 35 C			
5 tubes 10.0ml	0		
CONFIRMATION TEST (Brilliant Green Bile)			
24 hour incubation at 35 C	positive tubes		
tubes 10.0ml			
48 hour incubation at 35 C			
tubes 10.0ml			
MPN INDEX	<2.2 per 100ml		

These results indicate that the above sample is not contaminated as defined by the SAFE DRINKING WATER ACT for a given sample. Any positive reaction may constitute a contaminated sample for water systems monitoring supplies.

All method and page numbers make reference to STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTEWATER, sixteenth edition. APPROVED BY Lori Patney

GOULD energy

Gould Energy 30 Clairmont Avenue Thornwood New York 10594 914/769-7900
Warner Laboratories Division Gallitzin Road P.O Box 214 Cresson, Pennsylvania 16630 814/886-7400
Warner Laboratories of West Virginia Division Route 50 East P.O Box 98 Gormania West Virginia 26720 304/693-7613
Fuel Engineering Division 30 Clairmont Avenue, Thornwood, New York 10594 914/769-7900
St. Louis Energy Division 11591 Page Service Drive, St Louis Missouri 63146 314/432-0414
Weighing and Control Services, Inc. P.O Box 1483 Brandon, Florida 33511 813/681-5733

WARNER LABORATORIES DIVISION

DATE: 06-03-88
WARNER NO. S64785

EPRI/CQDC
P.O. BOX 98
HOMER CITY, PA 15748

DATE RECEIVED: 5/27/88

DATE/HOUR SAMPLED: 5/26/88
DATE ANALYZED: 5/27/88

SAMPLED BY :
ANALYZED BY: D.SMITHMYER, L.GEORGE

SAMPLE ID: SAMPLE 1B CISTERN
P.O. NO. 86001-157

CERTIFICATE OF ANALYSIS

CHEMICAL WATER ANALYSIS			METHOD NO.	PAGE REF. NO.
pH		6.70	<423>	<402>
ALKALINITY to pH 4.5		48.00 mg/L $CaCO_3$	<403>	<253>
TOTAL IRON	Less than	0.15 mg/L	<303>	<147>
TOT. SUSPENDED SOLIDS (RESIDUE)	N.D.	mg/L	<209D>	<94>
HARDNESS		1087.00 mg/L $CaCO_3$	<314B>	<195>

All analyses are performed in accordance with STANDARD METHODS FOR THE ANALYSIS OF WATER AND WASTEWATER, fifteenth edition.

APPROVED BY

APPENDIX G

ICP ANALYSIS DATA SHEETS

DOE SULFUR & ASH DATA SHEET A

DATE: 12-3-90 PAGE #: 1

TIME: ____________

Ar-FLOW RATE (l/min): 0.3

ICP POWER LEVEL: 1050 w

PRIMARY STANDARDS:

ELEMENT	WAVELENGTH	INTENSITY	CONCENTR.
S	1807.31 Å	48935	200 PPM
Si	2124.12 Å	34739	200 PPM
Al	3944.03 Å	4083	100 PPM
Fe	2733.55 Å	38910	100 PPM
Ca	4226.73 Å	20484	100 PPM
Mg	2790.8 Å	2474	50 PPM

DOE SULFUR & ASH DATA SHEET B

DATE: 12-3-90 PAGE #: 2

SAMPLE #: SECONDARY STD'S , % SOLIDS: 0

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----		
	S	~~SAMPLE~~ STD 4	TRIAL 1	------ 100	24537	99.63			------
	Si	~~SAMPLE~~ "	TRIAL 1	------ 100	16983	96.88			------
	Al	~~SAMPLE~~ "	TRIAL 1	------ 50	2160	49.85			------
	Fe	~~SAMPLE~~ "	TRIAL 1	------ 50	17834	45.14			------
	Ca	~~SAMPLE~~ "	TRIAL 1	------ 50	10701	51.32			------
	Mg	~~SAMPLE~~ "	TRIAL 1	------ 20	1171	21.38			------
	S	~~SAMPLE~~ "	TRIAL 2	------ 100	23649	95.47			------
	Si	~~SAMPLE~~ "	TRIAL 2	------ 100	17114	97.64			------
	Al	~~SAMPLE~~ "	TRIAL 2	------ 50	2414	56.48			------
	Fe	~~SAMPLE~~ "	TRIAL 2	------ 50	21029	53.46			------
	Ca	~~SAMPLE~~ "	TRIAL 2	------ 50	10528	50.46			------
	Mg	~~SAMPLE~~ "	TRIAL 2	------ 20	1111	20.06			------
	S	~~SAMPLE~~ "	TRIAL 3	------ 100	22623	91.75			------
	Si	~~SAMPLE~~ "	TRIAL 3	------ 100	15714	89.51			------
	Al	~~SAMPLE~~ "	TRIAL 3	------ 50	2193	50.70			------
	Fe	~~SAMPLE~~ "	TRIAL 3	------ 50	18042	45.68			------
	Ca	~~SAMPLE~~ "	TRIAL 3	------ 50	10297	49.31			------
	Mg	~~SAMPLE~~ "	TRIAL 3	------ 20	1065	19.04			------
	S	STANDAR 4	------	100	23809	96.63			------
	Si	STANDAR "	------	100	16195	92.30			------
	Al	STANDAR "	------	50	2306	53.66			------
	Fe	STANDAR "	------	50	18266	46.26			------
	Ca	STANDAR "	------	50	9183	43.77			------
	Mg	STANDAR "	------	20	1092	19.63			------
	---	-----	-----	-----	-----	-----	-----		

DOE SULFUR & ASH DATA SHEET B

DATE: 12-3-90 PAGE #: 3

SAMPLE #: *FCU-SQ3'-IC-1, % SOLIDS: 0.05%

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----		
	S	SAMPLE	TRIAL 1	------	12980	52.08			------
	Si	SAMPLE	TRIAL 1	------	2115	10.52			------
	Al	SAMPLE	TRIAL 1	------	470	5.79			------
	Fe	SAMPLE	TRIAL 1	------	4538	10.53			------
	Ca	SAMPLE	TRIAL 1	------	5502	25.45			------
	Mg	SAMPLE	TRIAL 1	------	475	6.08			------
	S	SAMPLE	TRIAL 2	------	12690	50.88			------
	Si	SAMPLE	TRIAL 2	------	1973	9.70			------
	Al	SAMPLE	TRIAL 2	------	436	4.89			------
	Fe	SAMPLE	TRIAL 2	------	4863	11.38			------
	Ca	SAMPLE	TRIAL 2	------	5396	24.92			------
	Mg	SAMPLE	TRIAL 2	------	482	6.23			------
	S	SAMPLE	TRIAL 3	------	14135	56.83			------
	Si	SAMPLE	TRIAL 3	------	2101	10.45			------
	Al	SAMPLE	TRIAL 3	------	455	5.39			------
	Fe	SAMPLE	TRIAL 3	------	4758	11.11			------
	Ca	SAMPLE	TRIAL 3	------	4910	22.51			------
	Mg	SAMPLE	TRIAL 3	------	473	6.02			------
	S	STANDAR #4	------	100	21230	86.02			------
	Si	STANDAR "	------	100	17432	99.48			------
	Al	STANDAR "	------	50	2073	47.59			------
	Fe	STANDAR "	------	50	18455	46.76			------
	Ca	STANDAR "	------	50	10493	50.29			------
	Mg	STANDAR "	------	20	1098	19.76			------
	---	-----	-----	-----	-----	-----	-----		

* CALIBRATION SAMPLE FROM FIELD COLLECTED SLURRY

DOE SULFUR & ASH DATA SHEET B

DATE: 12-3-90 PAGE #: 4

SAMPLE #: *CGO-SQ3'-IG-1 , % SOLIDS: 0.289 %

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----		
	S	SAMPLE	TRIAL 1	------	12385	49.63			------
	Si	SAMPLE	TRIAL 1	------	7343	40.89			------
	Al	SAMPLE	TRIAL 1	------	991	19.38			------
	Fe	SAMPLE	TRIAL 1	------	6655	16.04			------
	Ca	SAMPLE	TRIAL 1	------	6083	28.34			------
	Mg	SAMPLE	TRIAL 1	------	529	7.25			------
	S	SAMPLE	TRIAL 2	------	13271	53.28			------
	Si	SAMPLE	TRIAL 2	------	6105	33.70			------
	Al	SAMPLE	TRIAL 2	------	942	18.10			------
	Fe	SAMPLE	TRIAL 2	------	7329	17.80			------
	Ca	SAMPLE	TRIAL 2	------	5730	26.59			------
	Mg	SAMPLE	TRIAL 2	------	516	6.97			------
	S	SAMPLE	TRIAL 3	------	12322	49.37			------
	Si	SAMPLE	TRIAL 3	------	6586	36.49			------
	Al	SAMPLE	TRIAL 3	------	945	18.17			------
	Fe	SAMPLE	TRIAL 3	------	6394	15.36			------
	Ca	SAMPLE	TRIAL 3	------	5849	27.18			------
	Mg	SAMPLE	TRIAL 3	------	542	7.54			------
	S	STANDAR #4	------		22949	93.09			------
	Si	STANDAR "	------		14653	83.35			------
	Al	STANDAR "	------		2391	55.87			------
	Fe	STANDAR "	------		17909	45.34			------
	Ca	STANDAR "	------		10303	4[illegible].34			------
	Mg	STANDAR "	------		1105	19.93			------
	---	-----	-----	-----	-----	-----	-----		

* CALIBRATION SAMPLE FROM FIELD COLLECTED SLURRY

DOE SULFUR & ASH DATA SHEET A

PAGE #: 1

DATE: 11.27.90

TIME: 0800

Ar-FLOW RATE (l/min): 0.3

ICP POWER LEVEL: 1050 WATTS

PRIMARY STANDARDS:

ELEMENT	WAVELENGTH	INTENSITY	CONCENTR.
S	1807.31 Å	14042.6	50 ppm
Si	2124.12 Å	9336.12	50 ppm
Al	3944.03 Å	2349.52	50 ppm
Fe	2739.55 Å	19865.0	50 ppm
Ca	4226.73 Å	2442.77	10 ppm
Mg	2795.53 Å	156938.0	5 ppm

DOE SULFUR & ASH DATA SHEET B

DATE: 11.27.90 PAGE #: 2

SAMPLE #: SECONDARY STD. (STD #4) % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	...	-----	-----	-----	-----	-----	-----		
									3
0815	S	~~SAMPLE~~ STANDARD #4	~~TRIAL 1~~	20	5389	18.41	<10WATTS	0.3	------
	Si	~~SAMPLE~~ STD.	TRIAL 1	20	3787	19.28			------
	Al	~~SAMPLE~~ STD.	TRIAL 1	20	1133	20.55			------
	Fe	~~SAMPLE~~ STD.	TRIAL 1	20	7726	18.58			------
	Ca	~~SAMPLE~~ STD.	TRIAL 1	5	1427	4.91			------
	Mg	~~SAMPLE~~ STD	TRIAL 1	2	57137	1.81			------
0820	S	~~SAMPLE~~ STD.	TRIAL 2	20	5408	18.48	<10WATTS	0.3	------
	Si	~~SAMPLE~~ STD.	TRIAL 2	20	3717	18.90			------
	Al	~~SAMPLE~~ STD.	TRIAL 2	20	1211	22.43			------
	Fe	~~SAMPLE~~ STD.	TRIAL 2	20	7855	18.92			------
	Ca	~~SAMPLE~~ STD.	TRIAL 2	5	1460	5.08			------
	Mg	~~SAMPLE~~ STD	TRIAL 2	2	59426	1.88			------
0825	S	~~SAMPLE~~ STD.	TRIAL 3	20	5530	19.82	<10WATTS	0.3	------
	Si	~~SAMPLE~~ STD	TRIAL 3	20	3884	19.82			------
	Al	~~SAMPLE~~ STD.	TRIAL 3	20	1163	21.26			------
	Fe	~~SAMPLE~~ STD	TRIAL 3	20	7516	18.04			------
	Ca	~~SAMPLE~~ STD	TRIAL 3	5	1394	4.77			------
	Mg	~~SAMPLE~~ STD	TRIAL 3	2	53244	1.69			------
0830	S	STANDAR	------	20	5762	19.77	<10WATTS	0.3	------
	Si	STANDAR	------	20	3811	19.42			------
	Al	STANDAR	------	20	1139	20.69			------
	Fe	STANDAR	------	20	7444	17.85			------
	Ca	STANDAR	------	5	1349	4.52			------
	Mg	STANDAR	------	2	55597	1.76			------
	...	-----	-----	-----	-----	-----	-----		

DOE SULFUR & ASH DATA SHEET B

DATE: 11.27.96 PAGE #: 3

SAMPLE #: FGC-SC4-1, % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----		3
0835	S	SAMPLE	TRIAL 1	------	34734	125.5	<10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	5488	28.70			------
	Al	SAMPLE	TRIAL 1	------	800	12.48			------
	Fe	SAMPLE	TRIAL 1	------	12775	31.72			------
	Ca	SAMPLE	TRIAL 1	------	8698	41.36			------
	Mg	SAMPLE	TRIAL 1	------	381276	12.19			------
	S	SAMPLE	TRIAL 2	------					------
	Si	SAMPLE	TRIAL 2	------	shut down at this point				------
	Al	SAMPLE	TRIAL 2	------	to remake stds.				------
	Fe	SAMPLE	TRIAL 2	------					------
	Ca	SAMPLE	TRIAL 2	------					------
	Mg	SAMPLE	TRIAL 2	------					------
	S	SAMPLE	TRIAL 3	------					------
	Si	SAMPLE	TRIAL 3	------					------
	Al	SAMPLE	TRIAL 3	------					------
	Fe	SAMPLE	TRIAL 3	------					------
	Ca	SAMPLE	TRIAL 3	------					------
	Mg	SAMPLE	TRIAL 3	------					------
	S	STANDAR	------						------
	Si	STANDAR	------						------
	Al	STANDAR	------						------
	Fe	STANDAR	------						------
	Ca	STANDAR	------						------
	Mg	STANDAR	------						------
	---	-----	-----	-----	-----	-----	-----		

FGU-504

1) Calibrate using primary standards & concentrations as per test plan. Sulfur, calcium & magnesium were found to be higher in concentration than primary stds.

2) New primary & secondary standards prepared.

STD. #1 H_2O matrix

STD #2 S 200 ppm
Si 50 ppm
Al 50 ppm

STD #3 Fe 50 ppm
Ca 100 ppm
Mg 20 ppm

STD #4 - Secondary standard
S : 100 ppm
Si : 20 ppm
Al : 20 ppm
Fe : 25 ppm
Mg = 10 ppm
Ca : 50 ppm

DOE SULFUR & ASH DATA SHEET A

DATE: 11.27.96

PAGE #: 4

TIME: ____________

Ar-FLOW RATE (l/min): 0.3

ICP POWER LEVEL: 1050 WATTS

PRIMARY STANDARDS:

ELEMENT	WAVELENGTH	INTENSITY	CONCENTR.
S	1807.31 Å	49253.4	200 ppm
Si	2124.12 Å	9360.21	50 ppm
Al	3944.03 Å	2359.85	50 ppm
Fe	2739.55 Å	18185.0	50 ppm
Ca	4226.73 Å	20668.7	100 ppm
Mg	2796.0 Å	1176.66	20 ppm

New primary & secondary stds.

Concentrations of S, Ca & Mg increased

Changed wavelength of Mg to less sensitive line

DOE SULFUR & ASH DATA SHEET B

DATE: 11.27.92 PAGE #: 5

SAMPLE #: Secondary Std. (Std. #4) % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----		
								0.3	3
0935	S	[redacted] STANDARD #4	[redacted] 1	------ 100	26449	106.8	<10 WATTS	0.3	------
	Si	[redacted]	[redacted] 1	------ 25	4389	22.57			------
	Al	[redacted]	[redacted] 1	------ 25	1294	24.27			------
	Fe	[redacted]	[redacted] 1	------ 25	9547	25.05			------
	Ca	[redacted]	[redacted] 1	------ 50	9943	46.98			------
	Mg	[redacted]	[redacted] 1	------ 10	688	9.73			------
0940	S	[redacted] STANDARD #4	[redacted] 2	------ 100	28385	114.7	<10 WATTS	0.3	------
	Si	[redacted]	[redacted]	------ 25	4541	23.41			------
	Al	[redacted]	[redacted] 2	------ 25	1349	25.60			------
	Fe	[redacted]	[redacted] 2	------ 25	9198	24.08			------
	Ca	[redacted]	[redacted] 2	------ 50	10479	49.63			------
	Mg	[redacted]	[redacted]	------ 10	661	9.15			------
0945	S	[redacted] STANDARD #4	[redacted] 3	------ 100	24805	100.0	<10 WATTS	0.3	------
	Si	[redacted]	[redacted] 3	------ 25	4656	24.05			------
	Al	[redacted]	[redacted] 3	------ 25	1302	24.47			------
	Fe	[redacted]	[redacted] 3	------ 25	8766	22.71			------
	Ca	[redacted]	[redacted] 3	------ 50	9529	44.94			------
	Mg	[redacted]	[redacted]	------ 10	704	10.07			------
0950	S	STANDAR #4	------	100	23595	95.09	<10 WATTS	0.3	------
	Si	STANDAR	------	25	4382	22.53			------
	Al	STANDAR	------	25	1510	29.49			------
	Fe	STANDAR	------	25	8690	22.66			------
	Ca	STANDAR	------	50	9949	47.01			------
	Mg	STANDAR	------	10	705	10.09			------
	---	-----	-----	-----	-----	-----	-----		

DOE SULFUR & ASH DATA SHEET B

DATE: 11.27.90 PAGE #: 6

SAMPLE #: FGD-SC4-1 , % SOLIDS: ________

rinse with H_2O for 5 min before running std.

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----		
0955	S	SAMPLE	TRIAL 1	------	37870	153.5	<10WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	5071	26.34			------
	Al	SAMPLE	TRIAL 1	------	818	12.80			------
	Fe	SAMPLE	TRIAL 1	------	12970	34.61			------
	Ca	SAMPLE	TRIAL 1	------	8793	41.30			------
	Mg	SAMPLE	TRIAL 1	------	900	14.17			------
1000	S	SAMPLE	TRIAL 2	------	35708	144.6	<10WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	4601	23.76			------
	Al	SAMPLE	TRIAL 2	------	882	14.33			------
	Fe	SAMPLE	TRIAL 2	------	12614	33.62			------
	Ca	SAMPLE	TRIAL 2	------	8294	38.84			------
	Mg	SAMPLE	TRIAL 2	------	880	13.76			------
1005	S	SAMPLE	TRIAL 3	------	34265	138.7	<10WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	4272	21.93			------
	Al	SAMPLE	TRIAL 3	------	784	11.98			------
	Fe	SAMPLE	TRIAL 3	------	11295	29.93			------
	Ca	SAMPLE	TRIAL 3	------	8412	39.42			------
	Mg	SAMPLE	TRIAL 3	------	895	14.08			------
1015	S	STANDAR	------	100	24948	100.6	<10WATTS	0.3	------
	Si	STANDAR	------	25	4116	21.07			------
	Al	STANDAR	------	25	1372	26.17			------
	Fe	STANDAR	------	25	8692	22.67			------
	Ca	STANDAR	------	50	10059	47.56			------
	Mg	STANDAR	------	10	668	9.30			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

Check uptake while rinsing

DOE SULFUR & ASH DATA SHEET B

DATE: 11.27.90 PAGE #: 7

SAMPLE #: FGC-SC4-2 , % SOLIDS: ____

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	
1020	S	SAMPLE	TRIAL 1	------	33807	136.8	<10WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	5064	26.30			------
	Al	SAMPLE	TRIAL 1	------	783	11.96			------
	Fe	SAMPLE	TRIAL 1	------	9694	25.46			------
	Ca	SAMPLE	TRIAL 1	------	9256	43.59			------
	Mg	SAMPLE	TRIAL 1	------	899	14.16			------
1025	S	SAMPLE	TRIAL 2	------	34811	140.9	<10WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	4605	23.71			------
	Al	SAMPLE	TRIAL 2	------	819	12.82			------
	Fe	SAMPLE	TRIAL 2	------	11414	30.27			------
	Ca	SAMPLE	TRIAL 2	------	9505	44.82			------
	Mg	SAMPLE	TRIAL 2	------	953	15.29			------
1030	S	SAMPLE	TRIAL 3	------	32305	130.7	<10WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	4321	22.20			------
	Al	SAMPLE	TRIAL 3	------	790	12.11			------
	Fe	SAMPLE	TRIAL 3	------	10053	26.47			------
	Ca	SAMPLE	TRIAL 3	------	10522	49.84			------
	Mg	SAMPLE	TRIAL 3	------	874	13.64			------
5 min rinse → 1040	S	STANDAR	------	100	23813	95.98	<10WATTS	0.3	------
	Si	STANDAR	------	25	4102	20.99			------
	Al	STANDAR	------	25	1325	25.02			------
	Fe	STANDAR	------	25	8352	21.78			------
	Ca	STANDAR	------	50	9153	43.08			------
	Mg	STANDAR	------	10	657	9.09			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

DOE SULFUR & ASH DATA SHEET B

DATE: 11·27·92   PAGE #: 8

SAMPLE #: FGL-SC4-3 , % SOLIDS: ______

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----		
1045	S	SAMPLE	TRIAL 1	------	31434	127.1	<10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	4774	24.70			------
	Al	SAMPLE	TRIAL 1	------	834	13.17			------
	Fe	SAMPLE	TRIAL 1	------	8154	22.84			------
	Ca	SAMPLE	TRIAL 1	------	10352	49.01			------
	Mg	SAMPLE	TRIAL 1	------	821	13.79			------
1050	S	SAMPLE	TRIAL 2	------	34287	138.8	<10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	4481	23.08			------
	Al	SAMPLE	TRIAL 2	------	803	12.44			------
	Fe	SAMPLE	TRIAL 2	------	8949	23.39			------
	Ca	SAMPLE	TRIAL 2	------	9541	45.00			------
	Mg	SAMPLE	TRIAL 2	------	820	13.76			------
1055	S	SAMPLE	TRIAL 3	------	33938	137.4	<10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	4801	24.85			------
	Al	SAMPLE	TRIAL 3	------	795	12.25			------
	Fe	SAMPLE	TRIAL 3	------	8699	22.69			------
	Ca	SAMPLE	TRIAL 3	------	10152	48.02			------
	Mg	SAMPLE	TRIAL 3	------	905	14.30			------
5 min rinse → 1105	S	STANDAR	------	100	24440	98.55	<10 WATTS	0.3	------
	Si	STANDAR	------	25	4588	23.67			------
	Al	STANDAR	------	25	1278	23.90			------
	Fe	STANDAR	------	25	9143	23.93			------
	Ca	STANDAR	------	50	6382	29.38			------
	Mg	STANDAR	------	10	640	8.72			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

DOE SULFUR & ASH DATA SHEET B

DATE: 11-27-90 PAGE #: 9

SAMPLE #: FGU-SC4-4 , % SOLIDS: ______

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----		
	S	SAMPLE	TRIAL 1	------					------
1115					32633	129.6	<10WATTS	0.3	
	Si	SAMPLE	TRIAL 1	------					------
					4790	24.79			
	Al	SAMPLE	TRIAL 1	------					------
					766	11.53			
	Fe	SAMPLE	TRIAL 1	------					------
					10371	27.36			
	Ca	SAMPLE	TRIAL 1	------					------
					10405	49.27			
	Mg	SAMPLE	TRIAL 1	------					------
					874	13.65			
	S	SAMPLE	TRIAL 2	------					------
1120					36695	146.2	<10WATTS	0.3	
	Si	SAMPLE	TRIAL 2	------					------
					4286	22.02			
	Al	SAMPLE	TRIAL 2	------					------
					728	10.63			
	Fe	SAMPLE	TRIAL 2	------					------
					10237	26.98			
	Ca	SAMPLE	TRIAL 2	------					------
					10418	49.33			
	Mg	SAMPLE	TRIAL 2	------					------
					897	14.11			
	S	SAMPLE	TRIAL 3	------					------
1125					34341	139.0	<10WATTS	0.3	
	Si	SAMPLE	TRIAL 3	------					------
					4170	21.37			
	Al	SAMPLE	TRIAL 3	------					------
					741	10.93			
	Fe	SAMPLE	TRIAL 3	------					------
					10154	26.75			
	Ca	SAMPLE	TRIAL 3	------					------
					11482	54.59			
	Mg	SAMPLE	TRIAL 3	------					------
					838	12.88			
5 min. rinse →	S	STANDAR	------						------
				100	27043	109.2	<10WATTS	0.3	
	Si	STANDAR	------						------
				25	4670	24.13			
	Al	STANDAR	------						------
				25	1288	24.13			
	Fe	STANDAR	------						------
				25	8363	21.75			
	Ca	STANDAR	------						------
				50	10326	48.88			
	Mg	STANDAR	------						------
				10	647	8.87			
	---	-----	-----	-----	-----	-----	-----		
								0.3	3

DOE SULFUR & ASH DATA SHEET A

DATE: 11.27.92 PAGE #: 10

TIME: 1300

Ar-FLOW RATE (l/min): 0.3

ICP POWER LEVEL: 1050 WATTS

PRIMARY STANDARDS:

ELEMENT	WAVELENGTH	INTENSITY	CONCENTR.
S	1807.31 Å	52839.8	200ppm
Si	2124.12 Å	9598.01	50ppm
Al	3944.03 Å	23393.98	50ppm
Fe	2739.55 Å	17094.2	50ppm
Ca	4226.73 Å	18947.6	100ppm
Mg	2795.53 Å	1221.09	20ppm

Calibration for afternoon analysis

DOE SULFUR & ASH DATA SHEET B

DATE: 11-27-90 PAGE #: 11

SAMPLE #: SECONDARY STD. (STD #4) % SOLIDS: ________

instrument recalibrated →

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
1310	S	[redacted] STANDARD #4	[redacted] 1	------ 100	24391	91.68	<10 watts	0.3	------
	Si	[redacted]	[redacted]	------ 25	4745	23.90			------
	Al	[redacted]	[redacted]	------ 25	1357	26.69			------
	Fe	[redacted]	[redacted] 1	------ 25	9412	26.76			------
	Ca	[redacted]	[redacted]	------ 50	9764	50.38			------
	Mg	[redacted]	[redacted] 1	------ 10	684	9.24			------
1315	S	[redacted]	[redacted] 2	------ 100	26740	100.6	<10 WATTS	0.3	------
	Si	[redacted]	[redacted]	------ 25	4764	24.00			------
	Al	[redacted]	[redacted] 2	------ 25	1352	26.55			------
	Fe	[redacted]	[redacted]	------ 25	9169	25.84			------
	Ca	[redacted]	[redacted]	------ 50	9823	50.70			------
	Mg	[redacted]	[redacted] 2	------ 10	699	9.55			------
1320	S	[redacted]	[redacted] 3	------ 100	23083	86.70	<10 WATTS	0.3	------
	Si	[redacted]	[redacted]	------ 25	4361	21.83			------
	Al	[redacted]	[redacted]	------ 25	1336	26.15			------
	Fe	[redacted]	[redacted]	------ 25	9345	26.56			------
	Ca	[redacted]	[redacted]	------ 50	10070	52.04			------
	Mg	[redacted]	[redacted]	------ 10	685	9.26			------
1325	S	STANDAR	------	100	24360	91.56	<10WATTS	0.3	------
	Si	STANDAR	------	25	4112	20.49			------
	Al	STANDAR	------	25	1276	24.66			------
	Fe	STANDAR	------	25	8947	25.35			------
	Ca	STANDAR	------	50	9643	49.93			------
	Mg	STANDAR	------	10	664	8.84			------
	---	-----	-----	-----	-----	-----	-----	0.3	3.0

DOE SULFUR & ASH DATA SHEET B

DATE: 11.27.90 PAGE #: 12

SAMPLE #: FGU-SC4-S , % SOLIDS: ______

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----		
1330	S	SAMPLE	TRIAL 1	------	34319	129.5	<10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	4233	21.15			------
	Al	SAMPLE	TRIAL 1	------	779	12.29			------
	Fe	SAMPLE	TRIAL 1	------	8208	23.12			------
	Ca	SAMPLE	TRIAL 1	------	11489	59.70			------
	Mg	SAMPLE	TRIAL 1	------	912	13.82			------
1335	S	SAMPLE	TRIAL 2	------	32605	123.0	<10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	3869	18.87			------
	Al	SAMPLE	TRIAL 2	------	744	11.56			------
	Fe	SAMPLE	TRIAL 2	------	9004	25.52			------
	Ca	SAMPLE	TRIAL 2	------	11665	60.65			------
	Mg	SAMPLE	TRIAL 2	------	867	12.91			------
1340	S	SAMPLE	TRIAL 3	------	35001	132.1	<10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	4457	22.35			------
	Al	SAMPLE	TRIAL 3	------	827	13.48			------
	Fe	SAMPLE	TRIAL 3	------	7833	21.98			------
	Ca	SAMPLE	TRIAL 3	------	10072	52.04			------
	Mg	SAMPLE	TRIAL 3	------	844	12.46			------
5 min rinse → 1350	S	STANDAR	------	100	25163	94.39	<10 WATTS	0.3	------
	Si	STANDAR	------	25	4373	21.90			------
	Al	STANDAR	------	25	1327	25.94			------
	Fe	STANDAR	------	25	8297	23.38			------
	Ca	STANDAR	------	50	9250	47.60			------
	Mg	STANDAR	------	10	668	8.93			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

DOE SULFUR & ASH DATA SHEET B

DATE: 11.27.92 PAGE #: 13

SAMPLE #: HCC-SC4-6 , % SOLIDS: ____

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
1400	S	SAMPLE	TRIAL 1	------	34154	128.9	<10WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	4713	23.72			------
	Al	SAMPLE	TRIAL 1	------	858	14.26			------
	Fe	SAMPLE	TRIAL 1	------	8481	23.94			------
	Ca	SAMPLE	TRIAL 1	------	10926	56.66			------
	Mg	SAMPLE	TRIAL 1	------	838	12.33			------
1405	S	SAMPLE	TRIAL 2	------	32439	122.3	<10WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	4212	21.03			------
	Al	SAMPLE	TRIAL 2	------	787	12.49			------
	Fe	SAMPLE	TRIAL 2	------	9360	26.60			------
	Ca	SAMPLE	TRIAL 2	------	11599	60.80			------
	Mg	SAMPLE	TRIAL 2	------	882	13.21			------
1410	S	SAMPLE	TRIAL 3	------	32431	122.3	<10WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	4842	24.42			------
	Al	SAMPLE	TRIAL 3	------	792	12.62			------
	Fe	SAMPLE	TRIAL 3	------	8970	25.42			------
	Ca	SAMPLE	TRIAL 3	------	11771	61.22			------
	Mg	SAMPLE	TRIAL 3	------	902	13.61			------
5min rinse → 1420	S	STANDAR	------	100	24729	92.97	<10WATTS	0.3	------
	Si	STANDAR	------	25	4571	22.96			------
	Al	STANDAR	------	25	1306	25.41			------
	Fe	STANDAR	------	25	8408	23.72			------
	Ca	STANDAR	------	50	9759	50.35			------
	Mg	STANDAR	------	10	662	8.80			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

DOE SULFUR & ASH DATA SHEET B

DATE: 11.27.96 PAGE #: 14

SAMPLE #: FCC-SC4-7, % SOLIDS: ______

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (1/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
1425	S	SAMPLE	TRIAL 1	------	35282	133.1	<10WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	5049	25.53			------
	Al	SAMPLE	TRIAL 1	------	495	5.23			------
	Fe	SAMPLE	TRIAL 1	------	9642	27.45			------
	Ca	SAMPLE	TRIAL 1	------	11128	57.75			------
	Mg	SAMPLE	TRIAL 1	------	796	11.49			------
1430	S	SAMPLE	TRIAL 2	------	34227	129.1	<10WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	4944	24.97			------
	Al	SAMPLE	TRIAL 2	------	798	12.77			------
	Fe	SAMPLE	TRIAL 2	------	10236	29.26			------
	Ca	SAMPLE	TRIAL 2	------	11054	5735			------
	Mg	SAMPLE	TRIAL 2	------	865	12.87			------
1435	S	SAMPLE	TRIAL 3	------	33493	126.3	<10WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	2107	9.71			------
	Al	SAMPLE	TRIAL 3	------	805	12.94			------
	Fe	SAMPLE	TRIAL 3	------	10866	31.16			------
	Ca	SAMPLE	TRIAL 3	------	12014	62.54			------
	Mg	SAMPLE	TRIAL 3	------	856	12.69			------
5 min rinse → 1445	S	STANDAR #4	------	100	26013	97.85	<10WATTS	0.3	------
	Si	STANDAR	------	25	4309	21.55			------
	Al	STANDAR	------	25	1253	24.09			------
	Fe	STANDAR	------	25	8746	24.74			------
	Ca	STANDAR	------	50	10252	53.02			------
	Mg	STANDAR	------	10	680	9.16			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

DOE SULFUR & ASH DATA SHEET B

DATE: 11.27.92 PAGE #: 15

SAMPLE #: FGU-SC4-8 , % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
1500	S	SAMPLE	TRIAL 1	------	36109	136.3	<10WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	4316	21.59			------
	Al	SAMPLE	TRIAL 1	------	791	12.60			------
	Fe	SAMPLE	TRIAL 1	------	8568	24.20			------
	Ca	SAMPLE	TRIAL 1	------	12789	66.72			------
	Mg	SAMPLE	TRIAL 1	------	834	12.24			------
1505	S	SAMPLE	TRIAL 2	------	35058	132.3	<10WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	5046	25.51			------
	Al	SAMPLE	TRIAL 2	------	793	12.65			------
	Fe	SAMPLE	TRIAL 2	------	5792	15.80			------
	Ca	SAMPLE	TRIAL 2	------	11999	62.46			------
	Mg	SAMPLE	TRIAL 2	------	862	12.81			------
1510	S	SAMPLE	TRIAL 3	------	32550	122.7	<10WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	4404	22.06			------
	Al	SAMPLE	TRIAL 3	------	786	12.48			------
	Fe	SAMPLE	TRIAL 3	------	8225	23.17			------
	Ca	SAMPLE	TRIAL 3	------	12165	63.36			------
	Mg	SAMPLE	TRIAL 3	------	819	11.95			------
5min rinse → 1520	S	STANDAR #4	------	100	24468	91.74	<10WATTS	0.3	------
	Si	STANDAR	------	25	4426	22.18			------
	Al	STANDAR	------	25	1213	23.09			------
	Fe	STANDAR	------	25	8746	24.74			------
	Ca	STANDAR	------	50	9796	50.56			------
	Mg	STANDAR	------	10	653	8.63			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

DOE SULFUR & ASH DATA SHEET B

DATE: 11.27.92 PAGE #: 16

SAMPLE #: Secondary std. (std #4) , % SOLIDS: ________
After completion of Analysis

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
1525	S	S[redacted] Std. #4	T[redacted]1 1[redacted]	100	24316	41.39	<10 WATTS	0.3	------
	Si	S[redacted]	T[redacted]1	25	1317	5.46			------
	Al	S[redacted]	T[redacted]	25	1216	23.16			------
	Fe	S[redacted]	T[redacted] 1	25	8354	23.56			------
	Ca	S[redacted]E	[redacted] 1	50	10301	53.28			------
	Mg	S[redacted]	[redacted] 1	10	633	8.23			------
1530	S	S[redacted] Std. #4	T[redacted]2	100	23887	89.76	<10 WATTS	0.3	------
	Si	S[redacted]	T[redacted]2	25	1238	5.03			------
	Al	S[redacted]	T[redacted]2	25	1267	24.44	plugged		------
	Fe	[redacted]	[redacted]	25	8894	25.19			------
	Ca	S[redacted]	T[redacted] 2	50	8799	45.17			------
	Mg	S[redacted]	T[redacted]2	10	604	7.60			------
1545	S	[redacted] Std. #4	T[redacted]	100	28929	109.0			------
	Si	[redacted]	T[redacted]	25	5192	26.32			------
	Al	S[redacted]	T[redacted]	25	1389	27.47	New		------
	Fe	[redacted]	T[redacted]	25	4262	26.12	Torch		------
	Ca	SA[redacted]	[redacted]3	50	11016	57.14	<10 WATTS	0.3	3 ml/min
	Mg	S[redacted]	TR[redacted] 3	10	716	9.89			------
	S	STANDAR	------						------
	Si	STANDAR	------						------
	Al	STANDAR	------						------
	Fe	STANDAR	------						------
	Ca	STANDAR	------						------
	Mg	STANDAR	------						------
	---	-----	-----	-----	-----	-----	-----	0.3	3

SECONDARY STDS.

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	22.57	24.27	25.05	46.98	9.726	106.8
2	23.41	25.60	24.08	49.63	9.152	114.7
3	24.05	24.47	22.71	44.94	10.07	100.0
4	22.53	29.49	22.66	47.01	10.09	95.09
5	21.07	26.17	22.67	47.56	9.304	100.6
6	20.99	25.02	21.72	43.08	9.087	95.98
7	23.67	23.90	23.93	29.38	8.724	98.55
8	24.13	24.13	21.75	48.88	8.868	109.2
9	23.90	26.69	26.76	50.38	9.241	91.68
10	24.00	26.55	25.84	50.70	9.548	100.6
11	21.83	26.15	26.56	52.04	9.263	86.70
12	20.49	24.66	25.35	49.73	8.838	91.56
13	21.90	25.94	23.38	47.60	8.926	94.39
14	22.96	25.41	23.72	50.35	8.801	92.97
15	6.828	23.24	21.87	46.15	8.875	90.70
16	21.55	24.09	24.74	53.02	9.161	97.85
MEAN	21.62	25.36	23.92	47.34	9.230	97.96
±1 S.D.	4.12	1.51	1.66	5.45	0.430	7.36

ANALYSIS OF FGU-SC4-1

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	26.34	12.80	34.61	41.30	14.17	153.5
2	23.76	14.33	33.62	38.84	13.76	144.6
3	21.93	11.98	29.93	39.42	14.08	138.7
MEAN	24.01	13.03	32.72	39.85	14.01	145.6
±1 S.D.	2.21	1.20	2.46	1.29	0.22	7.4

ANALYSIS OF FGU-SC4-2

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	26.30	11.96	25.46	43.59	14.16	136.8
2	23.77	12.82	30.27	44.82	15.29	140.9
3	22.20	12.11	26.47	49.84	13.64	130.7
MEAN	24.09	12.30	27.40	46.08	14.36	136.2
±1 S.D.	2.07	0.46	2.53	3.31	0.85	5.2

ANALYSIS OF FGU-SC4-3

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	24.70	13.17	22.84	49.01	13.79	127.1
2	23.08	12.44	23.39	45.00	13.76	138.8
3	24.85	12.25	22.69	48.02	14.30	137.4
MEAN	24.21	12.62	22.97	47.34	13.95	134.4
±1 S.D.	0.98	0.49	0.37	2.09	0.30	6.4

ANALYSIS OF FGU-SC4-4

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	24.79	11.53	27.36	49.27	13.65	129.6
2	22.02	10.63	26.98	49.33	14.11	146.2
3	21.37	10.93	26.75	54.59	12.88	139.0
MEAN	22.72	11.03	27.03	51.06	13.55	138.3
±1 S.D.	1.82	0.46	0.31	3.05	0.62	8.3

ANALYSIS OF FGU-SC4-5

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	21.15	12.29	23.12	59.70	13.82	129.5
2	18.87	11.56	25.52	60.65	12.91	123.0
3	22.35	13.48	21.98	52.04	12.46	132.1
MEAN	20.79	12.44	23.54	57.47	13.06	128.2
±1 S.D.	1.77	0.97	1.81	4.72	0.69	4.7

ANALYSIS OF FGU-SC4-6

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	23.72	14.26	23.94	56.66	12.33	128.9
2	21.03	12.49	26.60	60.30	13.21	122.3
3	24.42	12.62	25.42	61.22	13.61	122.3
MEAN	23.06	13.12	25.32	59.39	13.05	124.5
±1 S.D.	1.79	0.99	1.33	2.41	0.66	3.8

ANALYSIS OF OF FGU-SC4-7

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	25.53	5.227	27.45	57.75	11.49	133.1
2	24.97	12.77	29.26	57.35	12.87	129.1
3	9.708	12.94	31.16	62.54	12.69	126.3
MEAN	20.070	10.31	29.29	59.21	12.35	129.5
±1 S.D.	8.978	4.41	1.85	2.89	0.75	3.4

ANALYSIS OF FGU-SC4-8

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	22.06	12.48	23.17	63.36	11.95	122.7
MEAN	22.06	12.48	23.17	63.36	11.95	122.7
±1 S.D.	0.00	0.00	0.00	0.00	0.00	0.0

ANALYSIS OF FGU-SC4-8 SEE ATTACHED

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	21.59	12.60	24.20	66.72	12.24	136.3
2	25.51	12.65	15.80	62.46	12.81	132.3
MEAN	23.55	12.63	20.00	64.59	12.53	134.3
±1 S.D.	2.78	0.03	5.94	3.02	0.40	2.8

FGU-SC4-8 VS. STDS. SI 2124.12

STD. Si : 20ppm

```
STEP ANG.               INCREMENT =    87.9 COUNTS      FULL SCALE = 5275.0 COUNTS

                  I....I....I....I....I....I....I....I....I....I....I....I....I
-16  2123.62         @
-15  2123.65         @
-14  2123.68         @
-13  2123.71         @
-12  2123.74         @
-11  2123.78         @
-10  2123.81         @
-9   2123.84         @
-8   2123.87         @
-7   2123.90         @*
-6   2123.93         @*
-5   2123.96         @*
-4   2123.99         @ $ *
-3   2124.03         @     $    *
-2   2124.06         @                  $      *
-1   2124.09         @                                   $  *
 0   2124.12         @                                          *             $
 1   2124.15         @                                       *         $
 2   2124.18         @                         *              $
 3   2124.21         @         *              $
 4   2124.24         @  *     $
 5   2124.28         @* $
 6   2124.31         @*
 7   2124.34         @*
 8   2124.37         @$
 9   2124.40         @
10   2124.43         @
11   2124.46         @
12   2124.49         @
13   2124.53         @
14   2124.56         @
15   2124.59         @
16   2124.62         @
                  I....I....I....I....I....I....I....I....I....I....I....I....I
```

@ = STANDARD#1-H20 MATRIX

* = STANDARD#4A-SECONDARY STD.

$ = FGU-SC4-8

FGU-SC4-8 VS. STDS. AL 3944.03

Std Al: 20ppm

```
STEP  ANG.          INCREMENT =   20.9 COUNTS     FULL SCALE = 1255.0 COUNTS

                    I....I....I....I....I....I....I....I....I....I....I....I....I
-16  3943.53                    @ $
-15  3943.56                     @$
-14  3943.59                   *@$
-13  3943.62                    @*$
-12  3943.65                    @*$
-11  3943.69                    @*$
-10  3943.72                    @* $
 -9  3943.75                     @ $
 -8  3943.78                     @$
 -7  3943.81                    @*$
 -6  3943.84                    @ *
 -5  3943.87                    @ *
 -4  3943.90                    @  $ *
 -3  3943.94                    @    $    *
 -2  3943.97                    @         $         *
 -1  3944.00                    @                $                 *
  0  3944.03                    @                        $                      *
  1  3944.06                    @                             $            *
  2  3944.09                     @                       $      *
  3  3944.12                     @             $*
  4  3944.15                     @    *$
  5  3944.19                    @  *
  6  3944.22                    @ *
  7  3944.25                    @*$
  8  3944.28                    @*$
  9  3944.31                    @*$
 10  3944.34                     @$
 11  3944.37                     @$
 12  3944.40                     @$
 13  3944.44                     @$
 14  3944.47                     @$
 15  3944.50                    @*$
 16  3944.53                     @$
                    I....I....I....I....I....I....I....I....I....I....I....I....I
```

@ = STANDARD#1-H2O MATRIX

* = STANDARD#4A-SECONDARY STD.

$ = FGU-SC4-8

FGU-SC4-8 VS. STDS. FE 2739.55

STD. Fe = 26 ppm

```
STEP ANG.        INCREMENT =  139.0 COUNTS     FULL SCALE = 8742.0 COUNTS

              I....I....I....I....I....I....I....I....I....I....I....I....I
-16  2739.05     @
-15  2739.08     @
-14  2739.11    @*
-13  2739.14     @
-12  2739.17     @
-11  2739.21     @
-10  2739.24     @
-9   2739.27     @
-8   2739.30     @
-7   2739.33     @
-6   2739.36     @
-5   2739.39     @*
-4   2739.42     @ $ *
-3   2739.46     @      $   *
-2   2739.49     @                   $      *
-1   2739.52     @                                           *$
 0   2739.55     @                                                  *    $
 1   2739.58     @                                               *      $
 2   2739.61     @                                *                    $
 3   2739.64     @              *              $
 4   2739.67     @   *    $
 5   2739.71     @*$
 6   2739.74     @$
 7   2739.77     @
 8   2739.80     @
 9   2739.83     @
 10  2739.86     @
 11  2739.89     @
 12  2739.92     @
 13  2739.96     @
 14  2739.99     @
 15  2740.02     @
 16  2740.05     @
              I....I....I....I....I....I....I....I....I....I....I....I....I
```

@ = STANDARD#1-H2O MATR

* = STANDARD#4A-SECONDARY STD.

$ = FGU-SC4-8

FGU-SC4-8 VS. STDS. CA 4226.73

STD. Ca = 5ppm

```
STEP  ANG.         INCREMENT =  210.4 COUNTS     FULL SCALE = 12622. COUNTS

                  I....I....I....I....I....I....I....I....I....I....I....I....
-16   4226.23       @
-15   4226.26       @
-14   4226.29       @
-13   4226.32       @
-12   4226.35       @
-11   4226.39       @
-10   4226.42       @
-9    4226.45       @
-8    4226.48       @$
-7    4226.51       @$
-6    4226.54       @ $
-5    4226.57       @  $
-4    4226.60       @      $
-3    4226.64       @*              $
-2        .67       @ *                              $
-1    4226.70       @   *                                               $
 0    4226.73       @    *                                                    $
 1    4226.76       @    *                                         $
 2    4226.79       @  *                       $
 3    4226.82       @*         $
 4    4226.85       @   $
 5    4226.89       @ $
 6    4226.92       @$
 7    4226.95       @$
 8    4226.98       @
 9    4227.01       @
 10   4227.04       @
 11   4227.0        @
 12   4227.         @
 13   422   .4      @
 14   42    .17     @
 15      7.20       @
 16    227.23       @
                  I....I....I....I....I....I....I....I....I....I....I....I....I
```

@ = STANDARD#1-H2O MATRIX

* = STANDARD#4A-SECONDARY STD.

$ = FGU-SC4-8

FGU-SC4-8 VS. STDS. MG 2790.8

STD. Mg : 2ppm

```
STEP  ANG.        INCREMENT =    14.5 COUNTS     FULL SCALE =  873.0 COUNTS

                      I....I....I....I....I....I....I....I....I....I....I....I....I
 -16  2790.30                       @
 -15  2790.33                       @
 -14  2790.36                       @$
 -13  2790.39                       @$
 -12  2790.42                       @$
 -11  2790.46                       @$
 -10  2790.49                       @$
      2790.52                       @$
  -8  2790.55                       @$
  -7  2790.58                       @*
  -6  2790.61                       @*
  -5  2790.64                       @$
  -4  2790.67                       @$
  -3  2790.71                       @*  $
  -2  2790.74                       @ *  $
  -1  2790.77                            *      $
   0  2790.80                       @      *                  $
   1  2790.83                       @      *
   2  2790.86                       @     *                                       $
   3  2790.89                       @  *                                   $
   4  2790.92                       @*                       $
   5  2790.96                       @         $
   6  2790.99                      @*  $
   7  2791.02                       @*$
   8  2791.05                       @ $
   9  2791.08                       @
  10  2791.11                         $
  11  2791.14                       @ $
  12  2791.17                       @$
  13  2791.21                       @$
  14  2791.24                       @$
  15  2791.27                       @$
  16  2791.30                       @$
                      I....I....I....I....I....I....I....I....I....I....I....I....I
```

@ = STANDARD#1-H2O MATRIX

* = STANDARD#4A-SECONDARY STD.

$ = FGU-SC4-8

FGU-SC4-8 VS. STDS. S 1807.31

STD. S = 20ppm

```
STEP  ANG.        INCREMENT =  315.6 COUNTS      FULL SCALE = 18936. COUNTS

               I....I....I....I....I....I....I....I....I....I....I....I....I
-16   1806.81   @
-15   1806.84   @
-14   1806.87   @
-13   1806.90   @
-12   1806.93   @
-11   1806.97   @
-10   1807.00   @
-9    1807.03   @
-8    1807.[illegible]  @*
-7    1807.[illegible]   @
-6    1807.12   @
-5    1807.15   @
-4    1807.18   @$
-3    1807.22   @   $
-2    1807.25   @             $
-1    1807.28   @*                                   $
 0    1807.31   @    *                                                  $
 1    1807.34   @       *                                                  $
 2    1807.37   @        *                                             $
 3    1807.40   @      *                       $
 4    1807.43   @   *         $
 5    1807.47   @  $
 6    1807.50   @$
 7    1807.53   @
 8    1807.[illegible]   @
 9    1807.59   @
10    1807.62  @*
11    1807.65   @
12    1807.68   @
13    1807.72   @
14    1807.75   @
15    1807.78   @
16    1807.81   @
               I....I....I....I....I....I....I....I....I....I....I....I....I
```

@ = STANDARD#1-H2O MATRIX

* = STANDARD#4A-SECONDARY STD.

$ = FGU-SC4-8

DOE SULFUR & ASH DATA SHEET A

DATE: 11·28·90 PAGE #: 1

TIME: 1245

Ar-FLOW RATE (l/min): 3

ICP POWER LEVEL: 1050 WATTS

PRIMARY STANDARDS:

ELEMENT	WAVELENGTH	INTENSITY	CONCENTR.
S	1807.31 Å	24132.2	100ppm
Si	2124.12 Å	34192.8	200ppm
Al	3944.03 Å	4590.72	100ppm
Fe	2739.55 Å	37665.2	100ppm
Ca	4226.73 Å	10528.8	50ppm
Mg	2790.8 Å	725.50	10ppm

DOE SULFUR & ASH DATA SHEET B

DATE: 11.28.90 PAGE #: 2

SAMPLE #: SECONDARY STD. (STD #4) % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
1300	S	[redacted] STANDARD #4	[redacted]	50	13634	46.23	<10 WATTS	0.3	------
	Si	S[redacted]	T[redacted]	100	18884	1097			------
	Al	S[redacted]	[redacted] 1	50	2292	46.85			------
	Fe	[redacted]	[redacted]1	50	18173	47.50			------
	Ca	S[redacted]	[redacted]1	20	4403	19.73			------
	Mg	S[redacted]	T[redacted]	5	445	4.53			------
1305	S	S[redacted] STD. #4	T[redacted]	50	13446	45.58	<10 WATTS	0.3	------
	Si	[redacted]	T[redacted]	100	18547	107.7			------
	Al	S[redacted]	[redacted]	50	2430	50.06			------
	Fe	S[redacted]	T[redacted]	50	17297	45.15			------
	Ca	S[redacted]LE	T[redacted]	20	3986	17.67			------
	Mg	S[redacted]LE	T[redacted] 2	5	440	4.43			------
1310	S	S[redacted]E STD #4	[redacted]3	50	13521	45.84	<10 WATTS	0.3	------
	Si	S[redacted]	T[redacted]3	100	18429	107.0			------
	Al	S[redacted]	T[redacted]	50	2463	50.80			------
	Fe	S[redacted]	T[redacted]	50	16863	43.82			------
	Ca	S[redacted]	T[redacted]	20	4473	20.08			------
	Mg	S[redacted]	[redacted]	5	451	4.65			------
1315	S	STANDAR #4	------	50	13706	46.48	<10WATTS	0.3	------
	Si	STANDAR	------	100	17847	103.6			------
	Al	STANDAR	------	50	2395	49.24			------
	Fe	STANDAR	------	50	18845	49.31			------
	Ca	STANDAR	------	20	4302	19.24			------
	Mg	STANDAR	------	5	456	4.74			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

DOE SULFUR & ASH DATA SHEET B

DATE: 11·28·90 PAGE #: 3

SAMPLE #: CGO-SC4-1, % SOLIDS: ______

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----		
1320	S	SAMPLE	TRIAL 1	------	30745	105.6	<10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	14623	84.55			------
	Al	SAMPLE	TRIAL 1	------	2136	43.24			------
	Fe	SAMPLE	TRIAL 1	------	13309	3441			------
	Ca	SAMPLE	TRIAL 1	------	11364	54.13			------
	Mg	SAMPLE	TRIAL 1	------	950	14.38			------
1325	S	SAMPLE	TRIAL 2	------	13560	120.9	- WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	15718	91.01			------
	Al	SAMPLE	TRIAL 2	------	1852	36.67			------
	Fe	SAMPLE	TRIAL 2	------	13949	36.13			------
	Ca	SAMPLE	TRIAL 2	------	12006	57.30			------
	Mg	SAMPLE	TRIAL 2	------	999	15.34			------
	S	SAMPLE	TRIAL 3	------					------
	Si	SAMPLE	TRIAL 3	------					------
	Al	SAMPLE	TRIAL 3	------					------
	Fe	SAMPLE	TRIAL 3	------					------
	Ca	SAMPLE	TRIAL 3	------					------
	Mg	SAMPLE	TRIAL 3	------					------
	S	STANDAR	------						------
	Si	STANDAR	------						------
	Al	STANDAR	------						------
	Fe	STANDAR	------						------
	Ca	STANDAR	------						------
	Mg	STANDAR	------						------
	---	-----	-----	-----	-----	-----	-----		

Ca, Mg & Fe too high in calibration standards

repeat w/ new stds.

DOE SULFUR & ASH DATA SHEET A

DATE: 12.2.90

PAGE #: 4

TIME: 0630

Ar-FLOW RATE (l/min): 0.3

ICP POWER LEVEL: 1050 WATTS

PRIMARY STANDARDS:

ELEMENT	WAVELENGTH	INTENSITY	CONCENTR.
S	1807.31 Å	51746.8	200 ppm
Si	2124.12 Å	35401.4	200 ppm
Al	3944.03 Å	4292.07	100 ppm
Fe	2739.55 Å	36278.3	100 ppm
Ca	4226.73 Å	21166.3	100 ppm
Mg	2790.8 Å	2457.72	50 ppm

DOE SULFUR & ASH DATA SHEET B

DATE: 12-2-90 PAGE #: 5

SAMPLE #: Secondary Std. (Std. #4), % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
0705	S	[redacted] STANDARD #4	[redacted]	100	26942	103.5	<10WATTS	0.3	------
	Si	[redacted]	[redacted]	100	17742	99.43			------
	Al	[redacted]	[redacted]	50	2210	48.26			------
	Fe	[redacted]	[redacted]	50	17047	46.36			------
	Ca	[redacted]	[redacted]	50	10232	47.32			------
	Mg	[redacted]	[redacted]	20	1167	21.80			------
0710	S	[redacted] Std #4	[redacted]	100	26678	102.5	<10WATTS	0.3	------
	Si	[redacted]	[redacted]	100	17922	100.5			------
	Al	[redacted]	[redacted]	50	2314	50.85			------
	Fe	[redacted]	[redacted]	50	16652	45.13			------
	Ca	[redacted]	[redacted]	50	11673	51.37			------
	Mg	[redacted]	[redacted]	20	1127	20.46			------
0715	S	[redacted]	[redacted]	100	27014	102.2	<10WATTS	0.3	------
	Si	[redacted]	[redacted]	100	18229	102.2			------
	Al	[redacted]	[redacted]	50	2312	50.81			------
	Fe	[redacted]	[redacted]	50	16057	43.47			------
	Ca	[redacted]	[redacted]	50	9304	42.85			------
	Mg	[redacted]	[redacted]	20	—	—			------
0720	S	STANDAR #4	------	100	26503	101.8	<10WATTS	0.3	------
	Si	STANDAR	------	100	18739	105.1			------
	Al	STANDAR	------	50	2331	51.28			------
	Fe	STANDAR	------	50	17553	47.65			------
	Ca	STANDAR	------	50	10106	46.71			------
	Mg	STANDAR	------	20	1073	19.25			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

DOE SULFUR & ASH DATA SHEET B

DATE: 12.2.90 PAGE #: 6

SAMPLE #: CGC-SC4-1, % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
0725	S	SAMPLE	TRIAL 1	------	33634	129.6	<10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	14746	82.37			------
	Al	SAMPLE	TRIAL 1	------	1885	40.21			------
	Fe	SAMPLE	TRIAL 1	------	12547	33.65			------
	Ca	SAMPLE	TRIAL 1	------	11985	55.77			------
	Mg	SAMPLE	TRIAL 1	------	1000	17.63			------
0730	S	SAMPLE	TRIAL 2	------	33323	128.3	<10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	16526	92.51			------
	Al	SAMPLE	TRIAL 2	------	2029	43.78			------
	Fe	SAMPLE	TRIAL 2	------	13419	36.9			------
	Ca	SAMPLE	TRIAL 2	------	12408	57.80			------
	Mg	SAMPLE	TRIAL 2	------	927	16.02			------
0735	S	SAMPLE	TRIAL 3	------	34781	134.0	<10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	15868	88.42			------
	Al	SAMPLE	TRIAL 3	------	2028	43.26			------
	Fe	SAMPLE	TRIAL 3	------	12592	33.78			------
	Ca	SAMPLE	TRIAL 3	------	11954	55.62			------
	Mg	SAMPLE	TRIAL 3	------	973	17.04			------
0745	S	STANDAR #4	------	100	25355	104.7	<10 WATTS	0.3	------
	Si	STANDAR	------	100	18668	104.7			------
	Al	STANDAR	------	50	2263	49.58			------
	Fe	STANDAR	------	50	17382	47.17			------
	Ca	STANDAR	------	50	10444	48.34			------
	Mg	STANDAR	------	20	1122	20.35			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

5 min rinse before std. analysis

DOE SULFUR & ASH DATA SHEET B

DATE: 12·2·90 PAGE #: 7

SAMPLE #: CGC-SCY-2 , % SOLIDS: ____

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (1/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
* 0750	S	SAMPLE	TRIAL 1	------	30517	117.4	* 18 WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	14836	82.88			------
	Al	SAMPLE	TRIAL 1	------	2033	43.88			------
	Fe	SAMPLE	TRIAL 1	------	14953	40.38			------
	Ca	SAMPLE	TRIAL 1	------	12656	59.0			------
	Mg	SAMPLE	TRIAL 1	------	992	17.46			------
* 0755	S	SAMPLE	TRIAL 2	------	12317	124.4	18 WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	14628	81.70			------
	Al	SAMPLE	TRIAL 2	------	2034	43.91			------
	Fe	SAMPLE	TRIAL 2	------	14786	39.91			------
	Ca	SAMPLE	TRIAL 2	------	11888	55.30			------
	Mg	SAMPLE	TRIAL 2	------	465	5.75**			------
* 0800	S	SAMPLE	TRIAL 3	------	32716	125.9	18 WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	15314	85.61			------
	Al	SAMPLE	TRIAL 3	------	1988	42.75			------
	Fe	SAMPLE	TRIAL 3	------	14620	39.45			------
	Ca	SAMPLE	TRIAL 3	------	13334	62.27			------
	Mg	SAMPLE	TRIAL 3	------	419	4.73**			------
	S	STANDAR	------		Rinse with H_2O for 5 min.				------
	Si	STANDAR	------		& rerun CGC-SCY-2				------
	Al	STANDAR	------		See page 8				------
	Fe	STANDAR	------						------
	Ca	STANDAR	------						------
	Mg	STANDAR	------						------
	---	-----	-----	-----	-----	-----	-----		

* Heavy coating of coal particles in spray chamber

** No peak found! Mg analysis not valid

DOE SULFUR & ASH DATA SHEET B

DATE: 12.2.90 PAGE #: 8

SAMPLE #: CGC-SC4-2 (2nd Run), % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (1/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----		
0805	S	SAMPLE	TRIAL 1	------	30000	115.4	10 WATTS*	0.3	------
	Si	SAMPLE	TRIAL 1	------	17470	97.88			------
	Al	SAMPLE	TRIAL 1	------	2075	44.93			------
	Fe	SAMPLE	TRIAL 1	------	13764	37.06			------
	Ca	SAMPLE	TRIAL 1	------	12753	59.47			------
	Mg	SAMPLE	TRIAL 1	------	975	17.07			------
0810	S	SAMPLE	TRIAL 2	------	34147	131.5	10-15 WATTS*	0.3	------
	Si	SAMPLE	TRIAL 2	------	16384	91.70			------
	Al	SAMPLE	TRIAL 2	------	2042	44.10			------
	Fe	SAMPLE	TRIAL 2	------	16269	44.00			------
	Ca	SAMPLE	TRIAL 2	------	14312	66.98			------
	Mg	SAMPLE	TRIAL 2	------	935	16.20			------
0815	S	SAMPLE	TRIAL 3	------	34604	133.3	15 WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	16799	94.06			------
	Al	SAMPLE	TRIAL 3	------	2153	46.86			------
	Fe	SAMPLE	TRIAL 3	------	15814	42.79			------
	Ca	SAMPLE	TRIAL 3	------	13861	64.80			------
	Mg	SAMPLE	TRIAL 3	------	1045	18.63			------
5 min rinse → 0820	S	STANDAR	------	100	30334	116.7	10 WATTS	0.3	------
	Si	STANDAR	------	100	20933	117.6			------
	Al	STANDAR	------	50	2982	67.46			------
	Fe	STANDAR	------	50	21486	58.65			------
	Ca	STANDAR	------	50	12702	59.22			------
	Mg	STANDAR	------	20	1293	24.14			------
	---	-----	-----	-----	-----	-----	-----		

* Reflective power unstable

DOE SULFUR & ASH DATA SHEET A

DATE: 12.2.90 PAGE #: 9

TIME: 0845

Ar-FLOW RATE (1/min): ____________________

ICP POWER LEVEL: ______

PRIMARY STANDARDS:

ELEMENT	WAVELENGTH	INTENSITY	CONCENTR.
S	1807.31 Å	60762.8	200 ppm
Si	2124.2 Å	41293.0	200 ppm
Al	3944.03 Å	6005.70	100 ppm
Fe	2739.55 Å	44482.3	100 ppm
Ca	4226.73 Å	24059.7	100 ppm
Mg	2790.8 Å	3131.19	50 ppm

DOE SULFUR & ASH DATA SHEET B

DATE: 12-2-90 PAGE #: ~~9~~ 10

SAMPLE #: Secondary std. after recalibration , % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----		
	S	SAMPLE	TRIAL 1	------					------
	Si	SAMPLE	TRIAL 1	------					------
	Al	SAMPLE	TRIAL 1	------					------
	Fe	SAMPLE	TRIAL 1	------					------
	Ca	SAMPLE	TRIAL 1	------					------
	Mg	SAMPLE	TRIAL 1	------					------
	S	SAMPLE	TRIAL 2	------					------
	Si	SAMPLE	TRIAL 2	------					------
	Al	SAMPLE	TRIAL 2	------					------
	Fe	SAMPLE	TRIAL 2	------					------
	Ca	SAMPLE	TRIAL 2	------					------
	Mg	SAMPLE	TRIAL 2	------					------
	S	SAMPLE	TRIAL 3	------					------
	Si	SAMPLE	TRIAL 3	------					------
	Al	SAMPLE	TRIAL 3	------					------
	Fe	SAMPLE	TRIAL 3	------					------
	Ca	SAMPLE	TRIAL 3	------					------
	Mg	SAMPLE	TRIAL 3	------					------
0855	S	STANDAR	------	100	19842	64.82			------
	Si	STANDAR	------	100	14547	64.72	15 WATTS	0.3	------
	Al	STANDAR	------	50	2006	30.83			------
	Fe	STANDAR	------	50	28709	63.48			------
	Ca	STANDAR	------	50	15761	65.02			------
	Mg	STANDAR	------	20	1802	27.50			------
	---	-----	-----	-----	-----	-----	-----		3

analysis unacceptable

DOE SULFUR & ASH DATA SHEET A

DATE: 12.2.90

PAGE #: 11

TIME:

Ar-FLOW RATE (l/min): 0.3

ICP POWER LEVEL:

PRIMARY STANDARDS:

ELEMENT	WAVELENGTH Å	INTENSITY	CONCENTR.
S	1807.31	53841.4	200ppm
Si	2124.12	41258	200ppm
Al	3944.03	5006.28	100ppm
Fe	2739.55	37369.8	100ppm
Ca	4226.73	21848.9	100ppm
Mg	2790.8	2843.38	50ppm

DOE SULFUR & ASH DATA SHEET B

DATE: 12-2-96 PAGE #: 12

SAMPLE #: Secondary std. (std.#4). % SOLIDS: ____

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----		
	S	SAMPLE	TRIAL 1	------					------
	Si	SAMPLE	TRIAL 1	------					------
	Al	SAMPLE	TRIAL 1	------					------
	Fe	SAMPLE	TRIAL 1	------					------
	Ca	SAMPLE	TRIAL 1	------					------
	Mg	SAMPLE	TRIAL 1	------					------
	S	SAMPLE	TRIAL 2	------					------
	Si	SAMPLE	TRIAL 2	------					------
	Al	SAMPLE	TRIAL 2	------					------
	Fe	SAMPLE	TRIAL 2	------					------
	Ca	SAMPLE	TRIAL 2	------					------
	Mg	SAMPLE	TRIAL 2	------					------
	S	SAMPLE	TRIAL 3	------					------
	Si	SAMPLE	TRIAL 3	------					------
	Al	SAMPLE	TRIAL 3	------					------
	Fe	SAMPLE	TRIAL 3	------					------
	Ca	SAMPLE	TRIAL 3	------					------
	Mg	SAMPLE	TRIAL 3	------					------
1410	S	STANDAR #4	------	100	21916	80.75			------
	Si	STANDAR	------	100	15189	72.87	12 WATTS		------
	Al	STANDAR	------	50	2330	43.87			------
	Fe	STANDAR	------	50	21917	58.15			------
	Ca	STANDAR	------	50	14308	64.90			------
	Mg	STANDAR	------	20	1590	26.41			------
	---	-----	-----	-----	-----	-----	-----		

[illegible]

DOE SULFUR & ASH DATA SHEET A

DATE: 12.2.90 PAGE #: 13

TIME: 0935

Ar-FLOW RATE (l/min): 0.3

ICP POWER LEVEL: 1650 WATTS

PRIMARY STANDARDS:

ELEMENT	WAVELENGTH Å	INTENSITY	CONCENTR.
S	1807.31	44446.7	200ppm
Si	2124.2	34136.1	200ppm
Al	3944.03	4493.39	100ppm
Fe	2739.55	39232.5	100ppm
Ca	4226.73	20311.0	100ppm
Mg	2790.8	2659.07	50ppm

DOE SULFUR & ASH DATA SHEET B

DATE: 12-2-96 PAGE #: 14

SAMPLE #: Secondary std. (std. #4), % SOLIDS: ______

After cleaning lenses

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
0950	S	S[redacted]E Standard #4	[redacted]1	------ 100	25892	106.2	<10 watts (0)	0.3	------
	Si	S[redacted]	[redacted] 1	------ 100	16013	92.86			------
	Al	S[redacted]E	T[redacted] 1	------ 50	2345	49.48			------
	Fe	S[redacted]	[redacted]1	------ 50	18735	47.07			------
	Ca	S[redacted]E	[redacted]1	------ 50	10361	50.07			------
	Mg	S[redacted]	[redacted] 1	------ 20	1133	19.03			------
0955	S	S[redacted] STD #4	[redacted] 2	------ 100	24346	99.82	<10 watts (2)	0.3	------
	Si	S[redacted]	[redacted]2	------ 100	17349	100.8			------
	Al	S[redacted]	T[redacted]	------ 50	2263	47.54			------
	Fe	S[redacted]	T[redacted]	------ 50	21152	53.35			------
	Ca	S[redacted]E	T[redacted]2	------ 50	10620	51.38			------
	Mg	S[redacted]	T[redacted]2	------ 20	1265	21.71			------
1000	S	S[redacted]E STD. #4	T[redacted] 3	------ 100	23371	95.77	<10 watts (0)	0.3	------
	Si	S[redacted]LE	T[redacted] 3	------ 100	17417	101.2			------
	Al	S[redacted]E	T[redacted]3	------ 50	2154	44.77			------
	Fe	S[redacted]E	T[redacted]3	------ 50	20374	51.32			------
	Ca	S[redacted]	[redacted]3	------ 50	9964	48.08			------
	Mg	S[redacted]E	[redacted]	------ 20	1214	20.68			------
1005	S	STANDAR #4	------	100	28963	119.0	(5) <10 watts	0.3	------
	Si	STANDAR	------	100	[illegible]	105.0			------
	Al	STANDAR	------	50	2112	43.98			------
	Fe	STANDAR	------	50	19313	46.58			------
	Ca	STANDAR	------	50	10067	48.60			------
	Mg	STANDAR	------	20	1151	19.36			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

DOE SULFUR & ASH DATA SHEET B

DATE: 12-2-90 PAGE #: 15

SAMPLE #: CG0-SC4-12 , % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
1010	S	SAMPLE	TRIAL 1	------	29189	119.7	(2) <10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	8837	50.38			------
	Al	SAMPLE	TRIAL 1	------	1261	23.70			------
	Fe	SAMPLE	TRIAL 1	------	15805	39.74			------
	Ca	SAMPLE	TRIAL 1	------	11189	54.23			------
	Mg	SAMPLE	TRIAL 1	------	802	12.31			------
1015	S	SAMPLE	TRIAL 2	------	26734	109.7	(2) <10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	9641	55.19			------
	Al	SAMPLE	TRIAL 2	------	1232	23.29			------
	Fe	SAMPLE	TRIAL 2	------	15148	37.83			------
	Ca	SAMPLE	TRIAL 2	------	10975	53.15			------
	Mg	SAMPLE	TRIAL 2	------	841	13.10			------
1020	S	SAMPLE	TRIAL 3	------	22410	116.7	(5) <10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	8361	47.63			------
	Al	SAMPLE	TRIAL 3	------	1275	24.30			------
	Fe	SAMPLE	TRIAL 3	------	15827	39.58			------
	Ca	SAMPLE	TRIAL 3	------	11085	53.90			------
	Mg	SAMPLE	TRIAL 3	------	810	12.46			------
5min rinse→ 1030	S	STANDAR #1	------	100	25407	164.2	(4-8) <10 WATTS	0.3	------
	Si	STANDAR	------	100	16319	95.03			------
	Al	STANDAR	------	50	2172	45.40			------
	Fe	STANDAR	------	50	19090	48.02			------
	Ca	STANDAR	------	50	10558	51.06			------
	Mg	STANDAR	------	20	1120	10.77			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

DOE SULFUR & ASH DATA SHEET B

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SAMPLE #: CGC-504-11 , % SOLIDS:

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
1035	S	SAMPLE	TRIAL 1	------	26572	109.1	(8) <10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	5083	28.25			------
	Al	SAMPLE	TRIAL 1	------	859	14.50			------
	Fe	SAMPLE	TRIAL 1	------	11957	29.60			------
	Ca	SAMPLE	TRIAL 1	------	11648	56.50			------
	Mg	SAMPLE	TRIAL 1	------	777	11.80			------
1040	S	SAMPLE	TRIAL 2	------	27227	111.8	(0) <10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	5186	28.86			------
	Al	SAMPLE	TRIAL 2	------	873	14.85			------
	Fe	SAMPLE	TRIAL 2	------	12343	30.59			------
	Ca	SAMPLE	TRIAL 2	------	11902	57.81			------
	Mg	SAMPLE	TRIAL 2	------	736	10.77			------
	S	SAMPLE	TRIAL 3	------	24429	100.4	(0) <10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	5201	28.94			------
	Al	SAMPLE	TRIAL 3	------	783	12.73			------
	Fe	SAMPLE	TRIAL 3	------	12082	29.92			------
	Ca	SAMPLE	TRIAL 3	------	11173	54.15			------
	Mg	SAMPLE	TRIAL 3	------	800	12.26			------
5 min rinse → 1045	S	STANDAR #4	------	100	24712	101.3	<10 WATTS	0.3	------
	Si	STANDAR	------	100	10285	94.47			------
	Al	STANDAR	------	50	2177	45.52			------
	Fe	STANDAR	------	50	18518	46.53			------
	Ca	STANDAR	------	50	11196	54.26			------
	Mg	STANDAR	------	20	1150	19.37			------
	---	-----	-----	-----	-----	-----	-----		

DOE SULFUR & ASH DATA SHEET B

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SAMPLE #: CG0-SC4-10 , % SOLIDS:

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (1/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
1050	S	SAMPLE	TRIAL 1	------	27909	114.6	<10 WATT	0.3	------
	Si	SAMPLE	TRIAL 1	------	12143	69.98			------
	Al	SAMPLE	TRIAL 1	------	1480	29.13			------
	Fe	SAMPLE	TRIAL 1	------	18440	46.33			------
	Ca	SAMPLE	TRIAL 1	------	13159	64.11			------
	Mg	SAMPLE	TRIAL 1	------	919	14.64			------
1055	S	SAMPLE	TRIAL 2	------	25331	103.9	<10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	11365	65.38			------
	Al	SAMPLE	TRIAL 2	------	1676	33.73			------
	Fe	SAMPLE	TRIAL 2	------	17657	44.31			------
	Ca	SAMPLE	TRIAL 2	------	13298	64.81			------
	Mg	SAMPLE	TRIAL 2	------	867	12.41			------
1100	S	SAMPLE	TRIAL 3	------	26806	110.0	<10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	11554	66.50			------
	Al	SAMPLE	TRIAL 3	------	1457	28.57			------
	Fe	SAMPLE	TRIAL 3	------	17746	44.54			------
	Ca	SAMPLE	TRIAL 3	------	14779	72.24			------
	Mg	SAMPLE	TRIAL 3	------	858	13.45			------
5 min rinse → [illegible]	S	STANDAR	------	100	25615	105.1	<10 WATTS	0.3	------
	Si	STANDAR	------	100	16386	95.06			------
	Al	STANDAR	------	50	2361	49.85			------
	Fe	STANDAR	------	50	18467	46.40			------
	Ca	STANDAR	------	50	11039	53.47			------
	Mg	STANDAR	------	20	1110	18.56			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

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SAMPLE #: CGC-SC4-9 , % SOLIDS: ______

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
1115	S	SAMPLE	TRIAL 1	------	27317	112.2	(2) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	12965	74.84			------
	Al	SAMPLE	TRIAL 1	------	1943	46.01			------
	Fe	SAMPLE	TRIAL 1	------	15362	38.39			------
	Ca	SAMPLE	TRIAL 1	------	13674	66.70			------
	Mg	SAMPLE	TRIAL 1	------	942	15.14			------
1120	S	SAMPLE	TRIAL 2	------	29469	121.1	(2) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	13209	76.26			------
	Al	SAMPLE	TRIAL 2	------	1761	35.72			------
	Fe	SAMPLE	TRIAL 2	------	17660	44.37			------
	Ca	SAMPLE	TRIAL 2	------	15173	74.22			------
	Mg	SAMPLE	TRIAL 2	------	914	14.58			------
1125	S	SAMPLE	TRIAL 3	------	30123	123.8	(4) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	14812	85.76			------
	Al	SAMPLE	TRIAL 3	------	1735	35.11			------
	Fe	SAMPLE	TRIAL 3	------	16902	42.36			------
	Ca	SAMPLE	TRIAL 3	------	14512	70.90			------
	Mg	SAMPLE	TRIAL 3	------	947	15.26			------
1130	S	STANDAR	------	100	25799	105.9	(4) <10WATTS	0.3	------
	Si	STANDAR	------	100	16792	97.47			------
	Al	STANDAR	------	50	2492	52.93			------
	Fe	STANDAR	------	50	19337	48.65			------
	Ca	STANDAR	------	50	10515	50.85			------
	Mg	STANDAR	------	20	1102	18.40			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

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SAMPLE #: CGC·SC4·8 , % SOLIDS: ______

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
1135	S	SAMPLE	TRIAL 1	------	29291	120.4	(8) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	14669	84.92			------
	Al	SAMPLE	TRIAL 1	------	2119	44.14			------
	Fe	SAMPLE	TRIAL 1	------	18350	46.10			------
	Ca	SAMPLE	TRIAL 1	------	13734	67.00			------
	Mg	SAMPLE	TRIAL 1	------	903	15.55			------
1140	S	SAMPLE	TRIAL 2	------	29242	120.2	(2) <10watts	0.3	------
	Si	SAMPLE	TRIAL 2	------	15079	87.34			------
	Al	SAMPLE	TRIAL 2	------	1942	39.99			------
	Fe	SAMPLE	TRIAL 2	------	16142	40.40			------
	Ca	SAMPLE	TRIAL 2	------	14551	71.10			------
	Mg	SAMPLE	TRIAL 2	------	934	14.98			------
1145	S	SAMPLE	TRIAL 3	------	29982	123.2	(2) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	17143	99.54			------
	Al	SAMPLE	TRIAL 3	------	1972	41.17			------
	Fe	SAMPLE	TRIAL 3	------	15836	39.61			------
	Ca	SAMPLE	TRIAL 3	------	14137	69.02			------
	Mg	SAMPLE	TRIAL 3	------	931	14.94			------
1150	S	STANDAR	------	100	24326	99.74	(2) <10WATTS	0.3	------
	Si	STANDAR	------	100	17774	103.3			------
	Al	STANDAR	------	50	2331	49.14			------
	Fe	STANDAR	------	50	19577	49.27			------
	Ca	STANDAR	------	50	10626	51.40			------
	Mg	STANDAR	------	20	1079	17.94			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

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SAMPLE #: C60-5C4-7 , % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
1155	S	SAMPLE	TRIAL 1	------	30717	126.3	(8) <10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	16486	95.66			------
	Al	SAMPLE	TRIAL 1	------	1857	37.98			------
	Fe	SAMPLE	TRIAL 1	------	16713	41.87			------
	Ca	SAMPLE	TRIAL 1	------	12971	63.17			------
	Mg	SAMPLE	TRIAL 1	------	916	14.51			------
1200	S	SAMPLE	TRIAL 2	------	29461	121.1	(6) <10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	13871	80.20			------
	Al	SAMPLE	TRIAL 2	------	1782	36.22			------
	Fe	SAMPLE	TRIAL 2	------	15759	39.41			------
	Ca	SAMPLE	TRIAL 2	------	13787	67.26			------
	Mg	SAMPLE	TRIAL 2	------	968	14.47			------
1205	S	SAMPLE	TRIAL 3	------	30464	125.0	(2) <10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	14255	82.47			------
	Al	SAMPLE	TRIAL 3	------	1868	36.84			------
	Fe	SAMPLE	TRIAL 3	------	17975	45.13			------
	Ca	SAMPLE	TRIAL 3	------	13793	67.30			------
	Mg	SAMPLE	TRIAL 3	------	925	14.80			------
1210	S	STANDAR	------	100	26219	107.6	<10 WATTS	0.3	------
	Si	STANDAR	------	100	17591	102.2			------
	Al	STANDAR	------	50	2284	48.03			------
	Fe	STANDAR	------	50	18533	46.57			------
	Ca	STANDAR	------	50	11250	54.54			------
	Mg	STANDAR	------	20	1128	18.92			------
	---	-----	-----	-----	-----	-----	-----	0.3	

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SAMPLE #: CGC-5C4-C , % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
12:15	S	SAMPLE	TRIAL 1	------	25917	106.4	(5) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	13146	75.91			------
	Al	SAMPLE	TRIAL 1	------	1677	33.20			------
	Fe	SAMPLE	TRIAL 1	------	15429	38.71			------
	Ca	SAMPLE	TRIAL 1	------	12926	62.15			------
	Mg	SAMPLE	TRIAL 1	------	841	13.09			------
1220	S	SAMPLE	TRIAL 2	------	29126	119.7	(2) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	13367	77.22			------
	Al	SAMPLE	TRIAL 2	------	1609	32.16			------
	Fe	SAMPLE	TRIAL 2	------	15795	39.50			------
	Ca	SAMPLE	TRIAL 2	------	13019	63.41			------
	Mg	SAMPLE	TRIAL 2	------	881	13.72			------
1225	S	SAMPLE	TRIAL 3	------	26823	110.1	(... <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	12032	69.33			------
	Al	SAMPLE	TRIAL 3	------	1546	30.67			------
	Fe	SAMPLE	TRIAL 3	------	15768	39.43			------
	Ca	SAMPLE	TRIAL 3	------	12228	59.44			------
	Mg	SAMPLE	TRIAL 3	------	850	13.29			------
1230	S	STANDAR	------	100	28467	98.25	(5) <10WATTS	0.3	------
	Si	STANDAR	------	100	15646	90.69			------
	Al	STANDAR	------	50	2337	49.29			------
	Fe	STANDAR	------	50	19584	49.28			------
	Ca	STANDAR	------	50	10349	50.01			------
	Mg	STANDAR	------	20	1110	18.56			------
	---	-----	-----	-----	-----	-----	-----	0.3	

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SAMPLE #: CG0-5C4-5 , % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
1230	S	SAMPLE	TRIAL 1	------	28435	116.8	(5) <10 WATTS		------
	Si	SAMPLE	TRIAL 1	------	13178	76.10			------
	Al	SAMPLE	TRIAL 1	------	1696	34.19			------
	Fe	SAMPLE	TRIAL 1	------	16045	46.15			------
	Ca	SAMPLE	TRIAL 1	------	13254	64.59			------
	Mg	SAMPLE	TRIAL 1	------	943	15.18			------
1235	S	SAMPLE	TRIAL 2	------	29666	121.9	(5) <10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	12933	74.65			------
	Al	SAMPLE	TRIAL 2	------	1708	34.48			------
	Fe	SAMPLE	TRIAL 2	------	16199	46.55			------
	Ca	SAMPLE	TRIAL 2	------	12125	58.43			------
	Mg	SAMPLE	TRIAL 2	------	972	15.75			------
1240	S	SAMPLE	TRIAL 3	------	28406	116.7	(5) <10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	13080	75.52			------
	Al	SAMPLE	TRIAL 3	------	1687	33.99			------
	Fe	SAMPLE	TRIAL 3	------	14353	35.78			------
	Ca	SAMPLE	TRIAL 3	------	13050	63.57			------
	Mg	SAMPLE	TRIAL 3	------	975	15.81			------
1245	S	STANDAR	------	100	24614	100.9	(5) <10 WATTS	0.3	------
	Si	STANDAR	------	100	16811	97.58			------
	Al	STANDAR	------	50	2106	43.83			------
	Fe	STANDAR	------	50	19430	48.29			------
	Ca	STANDAR	------	50	9818	47.35			------
	Mg	STANDAR	------	20	1074	17.82			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

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SAMPLE #: CG0·SC4-4 , % SOLIDS:

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
1250	S	SAMPLE	TRIAL 1	------	30258	124.4	(5) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	16514	95.22			------
	Al	SAMPLE	TRIAL 1	------	1989	41.10			------
	Fe	SAMPLE	TRIAL 1	------	15698	39.25			------
	Ca	SAMPLE	TRIAL 1	------	13450	65.58			------
	Mg	SAMPLE	TRIAL 1	------	927	14.86			------
1255	S	SAMPLE	TRIAL 2	------	31857	131.0	(3) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	14995	86.84			------
	Al	SAMPLE	TRIAL 2	------	1826	37.26			------
	Fe	SAMPLE	TRIAL 2	------	15817	39.56			------
	Ca	SAMPLE	TRIAL 2	------	12837	62.50			------
	Mg	SAMPLE	TRIAL 2	------	881	13.92			------
1300	S	SAMPLE	TRIAL 3	------	30092	123.7	(5) <10WATTS		------
	Si	SAMPLE	TRIAL 3	------	13254	76.55		0.3	------
	Al	SAMPLE	TRIAL 3	------	2235	46.87			------
	Fe	SAMPLE	TRIAL 3	------	17203	43.14			------
	Ca	SAMPLE	TRIAL 3	------	13775	67.20			------
	Mg	SAMPLE	TRIAL 3	------	942	15.15			------
1305	S	STANDAR	------	100	26244	107.7	<10WATTS	0.3	------
	Si	STANDAR	------	100	17664	102.6			------
	Al	STANDAR	------	50	2284	48.03			------
	Fe	STANDAR	------	50	19409	48.83			------
	Ca	STANDAR	------	50	10031	48.42			------
	Mg	STANDAR	------	20	1135	19.06			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

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SAMPLE #: C60-SC4-3, % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (1/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
1310	S	SAMPLE	TRIAL 1	------	24150	119.8	(2) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	15392	89.19			------
	Al	SAMPLE	TRIAL 1	------	2084	43.34			------
	Fe	SAMPLE	TRIAL 1	------	16267	40.72			------
	Ca	SAMPLE	TRIAL 1	------	12653	61.57			------
	Mg	SAMPLE	TRIAL 1	------	934	14.98			------
1315	S	SAMPLE	TRIAL 2	------	30895	127.0	(2) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	14074	81.40			------
	Al	SAMPLE	TRIAL 2	------	1724	39.68			------
	Fe	SAMPLE	TRIAL 2	------	16527	41.39			------
	Ca	SAMPLE	TRIAL 2	------	13625	66.15			------
	Mg	SAMPLE	TRIAL 2	------	963	15.58			------
1320	S	SAMPLE	TRIAL 3	------	30173	124.0	(2) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	15015	86.96			------
	Al	SAMPLE	TRIAL 3	------	2133	44.47			------
	Fe	SAMPLE	TRIAL 3	------	17096	42.86			------
	Ca	SAMPLE	TRIAL 3	------	14841	72.55			------
	Mg	SAMPLE	TRIAL 3	------	919	14.68			------
1330	S	STANDAR	------	100	24134	98.44	<10WATTS	0.3	------
	Si	STANDAR	------	100	17574	102.1			------
	Al	STANDAR	------	50	2265	47.57			------
	Fe	STANDAR	------	50	19303	48.56			------
	Ca	STANDAR	------	50	10310	49.82			------
	Mg	STANDAR	------	20	1153	19.84			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

DOE SULFUR & ASH DATA SHEET B

DATE: 12·3·90 PAGE #: 25

SAMPLE #: CGO-SC4-2, % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
0730	S	SAMPLE	TRIAL 1	------	27632	113.5	(5) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	14576	84.37			------
	Al	SAMPLE	TRIAL 1	------	1772	36.00			------
	Fe	SAMPLE	TRIAL 1	------	15334	38.31			------
	Ca	SAMPLE	TRIAL 1	------	12314	59.90			------
	Mg	SAMPLE	TRIAL 1	------	972	15.77			------
0735	S	SAMPLE	TRIAL 2	------	31192	126.3	(5) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	16017	92.84			------
	Al	SAMPLE	TRIAL 2	------	1972	40.68			------
	Fe	SAMPLE	TRIAL 2	------	15544	38.86			------
	Ca	SAMPLE	TRIAL 2	------	12668	62.35			------
	Mg	SAMPLE	TRIAL 2	------	965	15.62			------
0740	S	SAMPLE	TRIAL 3	------	28851	118.7	(5) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	15266	88.44			------
	Al	SAMPLE	TRIAL 3	------	1917	39.40			------
	Fe	SAMPLE	TRIAL 3	------	15664	39.18			------
	Ca	SAMPLE	TRIAL 3	------	13544	66.05			------
	Mg	SAMPLE	TRIAL 3	------	1021	16.75			------
0750	S	STANDAR #4	------	100	22890	93.77	(5) <10WATTS	0.3	------
	Si	STANDAR	------	100	17964	104.4			------
	Al	STANDAR	------	50	2214	46.38			------
	Fe	STANDAR	------	50	19445	50.22			------
	Ca	STANDAR	------	50	10266	49.60			------
	Mg	STANDAR	------	20	1015	16.63			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

DOE SULFUR & ASH DATA SHEET B

DATE: 12·3·90 PAGE #: 26

SAMPLE #: CGC-SC4-1 , % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
0800	S	SAMPLE	TRIAL 1	------	28355	116.5	(2) <10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	1391.2	80.44			------
	Al	SAMPLE	TRIAL 1	------	1964	46.51			------
	Fe	SAMPLE	TRIAL 1	------	12519	31.05			------
	Ca	SAMPLE	TRIAL 1	------	11432	55.45			------
	Mg	SAMPLE	TRIAL 1	------	1060	17.54			------
0805	S	SAMPLE	TRIAL 2	------	30744	126.4	(2) <10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	15183	87.95			------
	Al	SAMPLE	TRIAL 2	------	1950	46.18			------
	Fe	SAMPLE	TRIAL 2	------	14752	36.81			------
	Ca	SAMPLE	TRIAL 2	------	11932	57.96			------
	Mg	SAMPLE	TRIAL 2	------	912	14.53			------
0810	S	SAMPLE	TRIAL 3	------	28956	119.0	(2) <10 WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	14896	86.26			------
	Al	SAMPLE	TRIAL 3	------	1966	40.56			------
	Fe	SAMPLE	TRIAL 3	------	13239	32.91			------
	Ca	SAMPLE	TRIAL 3	------	12277	59.69			------
	Mg	SAMPLE	TRIAL 3	------	941	15.14			------
0820	S	STANDAR #4	------	100	24188	99.17	(2) <10 WATTS	0.3	------
	Si	STANDAR	------	100	16249	94.25			------
	Al	STANDAR	------	50	2426	51.38			------
	Fe	STANDAR	------	50	18924	47.06			------
	Ca	STANDAR	------	50	10371	50.12			------
	Mg	STANDAR	------	20	1079	17.42			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

DOE SULFUR & ASH DATA SHEET A

DATE: 12·3·90 PAGE #: 27

TIME: 0900

Ar-FLOW RATE (l/min): 0.3

ICP POWER LEVEL: 1050

PRIMARY STANDARDS:

ELEMENT	WAVELENGTH Å	INTENSITY	CONCENTR.
S	1807.31	48965.1	200
Si	2124.12	34738.5	200
Al	3944.03	4083.46	100
Fe	2739.55	38910.0	100
Ca	4226.73	20484.1	100
Mg	2790.8	24737.80	50

DOE SULFUR & ASH DATA SHEET B

DATE: 12.3.90 PAGE #: 28

SAMPLE #: SECONDARY STD. (STD. #4, % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
0925	S	[redacted]E STANDARD #4	[redacted]1	------ 100	24537	99.63	(1) <10WATTS	0.3	------
	Si	[redacted]E	[redacted] 1	------ 100	16983	96.88			------
	Al	S[redacted]LE	[redacted]1	------ 50	2160	49.85			------
	Fe	S[redacted]	T[redacted] 1	------ 50	17834	45.14			------
	Ca	S[redacted]	T[redacted]1	------ 50	10701	51.32			------
	Mg	[redacted]	T[redacted]	------ 20	1171	21.38			------
0930	S	S[redacted]E STD #4	[redacted]2	------ 100	23649	95.97	(2) <10WATTS	0.3	------
	Si	S[redacted]E	T[redacted]	------ 100	17114	97.64			------
	Al	S[redacted]	T[redacted]2	------ 50	2414	56.48			------
	Fe	[redacted]E	[redacted]	------ 50	21029	53.46			------
	Ca	S[redacted]	T[redacted] 2	------ 50	10528	50.46			------
	Mg	S[redacted]E	[redacted]	------ 20	1111	20.06			------
0935	S	S[redacted] STD #4	T[redacted]3	------ 100	22623	91.75	(5) <10WATTS	0.3	------
	Si	S[redacted]	[redacted] 3	------ 100	15714	89.51			------
	Al	S[redacted]E	[redacted] 3	------ 50	2193	50.70			------
	Fe	S[redacted]LE	TR[redacted] 3	------ 50	18042	45.68			------
	Ca	S[redacted]	[redacted]3	------ 50	10297	49.31			------
	Mg	[redacted]	T[redacted] 3	------ 20	1065	19.04			------
0940	S	STANDAR #4	------	100	23809	96.63	(5) <10WATTS	0.3	------
	Si	STANDAR	------	100	16195	92.30			------
	Al	STANDAR	------	50	2306	53.66			------
	Fe	STANDAR	------	50	18266	46.26			------
	Ca	STANDAR	------	50	9183	43.77			------
	Mg	STANDAR	------	20	1092	19.63			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

DOE SULFUR & ASH DATA SHEET B

DATE: 12-3-90 PAGE #: 29

SAMPLE #: FGU-503-1c-1 , % SOLIDS: ________

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
0945	S	SAMPLE	TRIAL 1	------	12980	52.08	(0) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	2115	10.52			------
	Al	SAMPLE	TRIAL 1	------	470	5.79			------
	Fe	SAMPLE	TRIAL 1	------	4538	10.53			------
	Ca	SAMPLE	TRIAL 1	------	5502	25.45			------
	Mg	SAMPLE	TRIAL 1	------	475	6.08			------
0950	S	SAMPLE	TRIAL 2	------	12688	50.88			------
	Si	SAMPLE	TRIAL 2	------	1973	9.70			------
	Al	SAMPLE	TRIAL 2	------	436	4.89			------
	Fe	SAMPLE	TRIAL 2	------	4863	11.38			------
	Ca	SAMPLE	TRIAL 2	------	5396	24.92			------
	Mg	SAMPLE	TRIAL 2	------	482	6.23			------
0955	S	SAMPLE	TRIAL 3	------	14135	56.83	(0) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	2101	10.45			------
	Al	SAMPLE	TRIAL 3	------	455	5.39			------
	Fe	SAMPLE	TRIAL 3	------	4758	11.11			------
	Ca	SAMPLE	TRIAL 3	------	4910	22.51			------
	Mg	SAMPLE	TRIAL 3	------	473	6.02			------
1000	S	STANDAR	------	100	21230	86.02	(0) <10WATTS	0.3	------
	Si	STANDAR	------	100	17432	99.48			------
	Al	STANDAR	------	50	2073	47.59			------
	Fe	STANDAR	------	50	18455	46.76			------
	Ca	STANDAR	------	50	10493	50.29			------
	Mg	STANDAR	------	20	1098	19.76			------
	---	-----	-----	-----	-----	-----	-----		

DOE SULFUR & ASH DATA SHEET B

DATE: 12-3-90 PAGE #: 36

SAMPLE #: CGO-SQ3-16-1 , % SOLIDS: ____

TIME	ELEM	SAMPLE/ STAND.	SAMPLE TRIAL #	STAND. PPM	ICP INTENS	CONCEN. PPM	REFLECT POWER	Q-ARGON (l/min)	Q-ANALYT (ml/min)
	---	-----	-----	-----	-----	-----	-----	0.3	3
1005	S	SAMPLE	TRIAL 1	------	12385	49.63	(2) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 1	------	7343	40.89			------
	Al	SAMPLE	TRIAL 1	------	991	19.38			------
	Fe	SAMPLE	TRIAL 1	------	6655	16.04			------
	Ca	SAMPLE	TRIAL 1	------	6083	28.34			------
	Mg	SAMPLE	TRIAL 1	------	529	7.25			------
1010	S	SAMPLE	TRIAL 2	------	13271	53.28	(2) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 2	------	6105	33.70			------
	Al	SAMPLE	TRIAL 2	------	942	18.10			------
	Fe	SAMPLE	TRIAL 2	------	7329	17.80			------
	Ca	SAMPLE	TRIAL 2	------	5730	26.59			------
	Mg	SAMPLE	TRIAL 2	------	516	6.97			------
1015	S	SAMPLE	TRIAL 3	------	12322	49.37	(4) <10WATTS	0.3	------
	Si	SAMPLE	TRIAL 3	------	6586	36.49			------
	Al	SAMPLE	TRIAL 3	------	945	18.17			------
	Fe	SAMPLE	TRIAL 3	------	6394	15.36			------
	Ca	SAMPLE	TRIAL 3	------	5849	27.18			------
	Mg	SAMPLE	TRIAL 3	------	542	7.54			------
1025	S	STANDAR	------	100	22949	93.69	(4) <10WATTS	0.3	------
	Si	STANDAR	------	100	14653	83.35			------
	Al	STANDAR	------	50	2391	55.87			------
	Fe	STANDAR	------	50	17909	45.34			------
	Ca	STANDAR	------	50	10303	49.34			------
	Mg	STANDAR	------	20	1105	19.93			------
	---	-----	-----	-----	-----	-----	-----	0.3	3

12.2.90

Used new standards, increased ppm in S, Ca & Mg

Standard #1 H_2O matrix

Standard #2 200 ppm Si
100 ppm Al
500 ppm S

Standard #3 100 ppm Fe
100 ppm Ca
50 ppm Mg

Standard #4 100 ppm [illegible]
100 ppm [illegible]
50 ppm Al
50 ppm Fe
50 ppm Ca
20 ppm Mg

Secondary std.

Duplicate run of sample CGO-SC4-1 went well. (data sheet, page [illegible])

CGO-SC4-2 deposited heavy layer of coal particles on spray chamber, reflected power immediately went to 18 watts. After analysis in triplicate rinsed for 5 min. with H_2O - ref. power down to 10 (data sheet, page 7). Reran CGO-SC4-2 in trip. - check recovery after standard results not [illegible] (page 8) [illegible] 1-5 ref. watts

Recalibrated and [illegible] (page 10). Ref. power ~12 watts [illegible]

Finished [illegible]

Recalibrate and rerun std. #4 ref. power at ~12 watts - results not acceptable.

Shut down - clean neb. - spray chamber - replace torch.

water [illegible] rate [illegible] 3 ml / min.

Very [illegible] - [illegible] - [illegible] had [illegible] [illegible].

Recalibrate - Ref power at <10 (0) watts

Run std #4 - [illegible] acceptable

Then run sample #12 first - [illegible] [illegible] - [illegible]

All 12 samples were run without any more problems.

The problem apparently was the particle in plasma torch

SECONDARY STD.(STD.#4) 12/3/90

_LEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	102.1	47.57	48.56	49.82	19.44	98.94
2	104.4	46.38	50.22	49.60	16.63	93.77
3	94.25	51.38	47.06	50.12	17.92	99.17
4	96.88	49.85	45.14	51.32	21.38	99.63
5	97.64	56.48	53.46	50.46	20.06	95.97
6	92.30	53.66	46.26	43.77	19.63	96.63
7	99.48	47.59	46.76	50.29	19.76	84.02
8	83.35	55.87	45.34	49.34	19.93	93.09
MEAN	96.30	51.10	47.85	49.34	19.34	95.40
±1 S.D.	6.54	3.91	2.82	2.33	1.45	4.51

ANALYSIS CGO-SQ3-1G-1

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	40.89	19.38	16.04	28.34	7.253	49.63
2	33.70	18.10	17.80	26.59	6.969	53.28
3	36.49	18.17	15.36	27.18	7.540	49.37
MEAN	37.03	18.55	16.40	27.37	7.254	50.76
±1 S.D.	3.63	0.72	1.26	0.89	0.286	2.18

ANALYSIS FGU-SQ3-1C-1

.LEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	10.52	5.790	10.53	25.45	6.076	52.08
2	9.697	4.894	11.38	24.92	6.234	50.88
3	10.45	5.387	11.11	22.51	6.023	56.83
MEAN	10.22	5.357	11.01	24.29	6.111	53.26
±1 S.D.	0.46	0.449	0.43	1.57	0.110	3.15

ANALYSIS CGO-SC4-1

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	80.44	40.51	31.05	55.45	17.54	116.5
2	87.95	40.18	36.81	57.96	14.53	126.4
3	86.26	40.56	32.91	59.69	15.14	119.0
MEAN	84.89	40.42	33.59	57.70	15.74	120.6
±1 S.D.	3.94	0.20	2.94	2.13	1.59	5.2

ANALYSIS CGO-SC4-2

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	84.37	36.00	38.31	59.90	15.77	113.5
2	92.89	40.68	38.86	62.35	15.62	128.3
3	88.44	39.40	39.18	66.05	16.75	118.7
MEAN	88.56	38.69	38.78	62.77	16.04	120.1
±1 S.D.	4.26	2.42	0.44	3.10	0.62	7.5

ANALYSIS CGO-SC4-3

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	86.96	44.47	42.86	72.55	14.68	124.0
MEAN	86.96	44.47	42.86	72.55	14.68	124.0
±1 S.D.	0.00	0.00	0.00	0.00	0.00	0.0

ANALYSIS CGO-SC4-3

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	89.19	43.34	40.72	61.57	14.98	119.8
2	81.40	39.68	41.39	66.45	15.58	127.0
MEAN	85.29	41.51	41.06	64.01	15.28	123.4
±1 S.D.	5.51	2.59	0.48	3.45	0.42	5.1

SECONDARY STD.(STD.#4) 12/2/90

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	92.86	49.48	47.09	50.07	19.03	106.2
2	100.8	47.54	53.35	51.38	21.71	99.82
3	101.2	44.97	51.32	8.879	20.68	95.77
4	105.0	43.98	48.58	48.60	19.38	119.0
5	95.03	45.40	48.02	51.06	18.77	104.2
6	94.47	45.52	46.53	54.26	19.37	101.3
7	95.06	49.85	46.40	53.47	18.56	105.1
8	97.47	52.93	48.65	50.85	18.40	105.9
9	103.3	49.14	49.27	51.40	17.94	99.74
10	102.2	48.03	46.57	54.54	18.92	107.6
11	90.69	49.29	49.28	50.01	18.56	98.25
12	97.58	43.83	48.89	47.35	17.82	100.9
13	102.6	48.03	48.83	48.42	19.06	107.7
MEAN	98.3	47.54	48.68	47.72	19.09	104.0
±1 S.D.	4.5	2.68	1.97	11.87	1.07	5.9

ANALYSIS CGO-SC4-4

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	95.82	41.10	39.25	65.58	14.86	124.4
2	86.84	37.26	39.56	62.50	13.92	131.0
3	76.55	46.87	43.14	67.20	15.15	123.7
MEAN	86.41	41.74	40.65	65.09	14.64	126.4
±1 S.D.	9.64	4.84	2.16	2.39	0.64	4.0

ANALYSIS CGO-SC4-5

.LEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	76.10	34.19	40.15	64.59	15.18	116.8
2	74.65	34.48	40.55	58.93	15.75	121.9
3	75.52	33.99	35.78	63.57	15.81	116.7
MEAN	75.42	34.22	38.82	62.36	15.58	118.5
±1 S.D.	0.73	0.25	2.64	3.02	0.35	3.0

ANALYSIS CGO-SC4-6

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	75.91	33.80	38.71	62.95	13.09	106.4
2	77.22	32.16	39.50	63.41	13.92	119.7
3	69.33	30.67	39.43	59.44	13.29	110.1
MEAN	74.15	32.21	39.22	61.93	13.43	112.1
±1 S.D.	4.23	1.57	0.44	2.17	0.43	6.9

ANALYSIS CGO-SC4-7

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	95.66	37.98	41.87	63.17	14.51	126.3
2	80.20	36.22	39.41	67.26	14.47	121.1
3	82.47	36.84	45.13	67.30	14.80	125.0
MEAN	86.11	37.01	42.14	65.91	14.59	124.1
±1 S.D.	8.35	0.89	2.87	2.37	0.18	2.7

ANALYSIS CGO-SC4-8

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	84.92	44.14	46.10	67.00	15.58	120.4
2	87.34	39.99	40.40	71.10	14.98	120.2
3	99.54	41.17	39.61	69.02	14.94	123.2
MEAN	90.60	41.77	42.03	69.04	15.17	121.3
±1 S.D.	7.84	2.14	3.54	2.05	0.36	1.7

ANALYSIS CGO-SC4-9

.LEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	74.84	40.01	38.39	66.70	15.14	112.2
2	76.28	35.72	44.37	74.22	14.58	121.1
3	85.76	35.11	42.36	70.90	15.26	123.8
MEAN	78.96	36.95	41.70	70.61	14.99	119.0
±1 S.D.	5.93	2.67	3.04	3.77	0.37	6.1

ANALYSIS CGO-SC4-10

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	69.98	29.13	46.33	64.11	14.69	114.6
2	65.38	33.73	44.31	64.81	12.41	103.9
3	66.50	28.57	44.54	72.24	13.45	110.0
MEAN	67.29	30.48	45.06	67.06	13.52	109.5
±1 S.D.	2.40	2.83	1.11	4.50	1.14	5.4

ANALYSIS CGO-SC4-11

ELEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	28.25	14.50	29.60	56.50	11.80	109.1
2	28.86	14.85	30.59	57.81	10.97	111.8
3	28.94	12.73	29.92	54.15	12.26	100.4
MEAN	28.68	14.03	30.04	56.15	11.68	107.1
±1 S.D.	0.38	1.14	0.51	1.85	0.65	5.9

ANALYSIS CGO-SC4-12

_LEMENT DATA SUMMARY (PPM)

RUN	SI	AL	FE	CA	MG	S
1	50.38	23.96	39.74	54.23	12.31	119.7
2	55.19	23.29	37.83	53.15	13.10	109.7
3	47.63	24.30	39.58	53.70	12.46	116.7
MEAN	51.07	23.85	39.05	53.69	12.62	115.4
±1 S.D.	3.83	0.52	1.06	0.54	0.42	5.1

COAL SLURRY ANALYSIS

NOTE: < INDICATES THAT THE RESULT IS LESS THAN THE GIVEN VALUE

DATE OF ANALYSIS: 12/2/90

	SAMPLE	SI	AL	FE	CA	MG	S
1	STD#4	69.72	30.83	63.48	65.02	27.50	64.82
1	STD#4	72.87	43.87	58.15	64.90	26.41	80.75
1	STD#4	92.86	49.48	47.09	50.07	19.03	106.2
2	STD#4	100.8	47.54	53.35	51.38	21.71	99.82
3	STD#4	101.2	44.97	51.32	8.879	20.68	95.77
4	STD#4	101.2	48.58	49.11	48.08	19.58	< 0.000
5	STD#4	105.0	43.98	48.58	48.60	19.38	119.0
1	CGO-SC4-12	50.38	23.96	39.74	54.23	12.31	119.7
2	CGO-SC4-12	55.19	23.29	37.83	53.15	13.10	109.7
3	CGO-SC4-12	47.63	24.30	39.58	53.70	12.46	116.7
6	STD#4	95.03	45.40	48.02	51.06	18.77	104.2
1	CGO-SC4-11	28.25	14.50	29.60	56.50	11.80	109.1
2	CGO-SC4-11	28.86	14.85	30.59	57.81	10.97	111.8
3	CGO-SC3-11	28.94	12.73	29.92	54.15	12.26	100.4
7	STD#4	94.47	45.52	46.53	54.26	19.37	101.3
1	CGO-SC4-10	69.98	29.13	46.33	64.11	14.69	114.6
2	CGO-SC4-10	65.38	33.73	44.31	64.81	12.41	103.9
3	CGO-SC4-10	66.50	28.57	44.54	72.24	13.45	110.0
8	STD#4	95.06	49.85	46.40	53.47	18.56	105.1
1	CGO-SC4-9	74.84	40.01	38.39	66.70	15.14	112.2
2	CGO-SC4-9	76.28	35.72	44.37	74.22	14.58	121.1
3	CGO-SC4-9	85.76	35.11	42.36	70.90	15.26	123.8
9	STD#4	97.47	52.93	48.65	50.85	18.40	105.9
1	CGO-SC4-8	84.92	44.14	46.10	67.00	15.58	120.4
2	CGO-SC4-8	87.34	39.99	40.40	71.10	14.98	120.2
3	CGO-SC4-8	99.54	41.17	39.61	69.02	14.94	123.2
10	STD#4	103.3	49.14	49.27	51.40	17.94	99.74
1	CGO-SC4-7	95.66	37.98	41.87	63.17	14.51	126.3
2	CGO-SC4-7	80.20	36.22	39.41	67.26	14.47	121.1
3	CGO-SC4-7	82.47	36.84	45.13	67.30	14.80	125.0
11	STD#4	102.2	48.03	46.57	54.54	18.92	107.6
1	CGO-SC4-6	75.91	33.80	38.71	62.95	13.09	106.4
2	CGO-SC4-6	77.22	32.16	39.50	63.41	13.92	119.7
2	CGO-SC4-6	69.33	30.67	39.43	59.44	13.29	110.1
12	STD#4	90.69	49.29	49.28	50.01	18.56	98.25
1	CGO-SC4-5	76.10	34.19	40.15	64.59	15.18	116.8
2	CGO-SC4-5	74.65	34.48	40.55	58.93	15.75	121.9
3	CGO-SC4-5	75.52	33.99	35.78	63.57	15.81	116.7
13	STD#4	97.58	43.83	48.89	47.35	17.82	100.9
1	CGO-SC4-4	95.82	41.10	39.25	65.58	14.86	124.4
2	CGO-SC4-4	86.84	37.26	39.56	62.50	13.92	131.0
3	CGO-SC4-4	76.55	46.87	43.14	67.20	15.15	123.7
14	STD#4	102.6	48.03	48.83	48.42	19.06	107.7
1	CGO-SC4-3	89.19	43.34	40.72	61.57	14.98	119.8
2	CGO-SC4-3	81.40	39.60	41.39	66.45	15.58	127.0

COAL SLURRY ANALYSIS

NOTE: < INDICATES THAT THE RESULT IS LESS THAN THE GIVEN VALUE

DATE OF ANALYSIS: 12/2/90

	SAMPLE	SI	AL	FE	CA	MG	S
3	CGO-SC4-3	86.96	44.47	42.86	72.55	14.68	124.0
1	STD#4	102.1	47.57	48.56	49.82	19.44	98.94
1	CGO-SC4-2	84.37	36.00	38.31	59.90	15.77	113.5
2	CGO-SC4-2	92.89	40.68	38.86	62.35	15.62	128.3
3	CGO-SC4-2	88.44	39.40	39.18	66.05	16.75	118.7
2	STD#4	104.4	46.38	50.22	49.60	16.63	93.77
1	CGO-SC4-1	80.44	40.51	31.05	55.45	17.54	116.5
2	CGO-SC4-1	87.95	40.18	36.81	57.96	14.53	126.4
3	CGO-SC4-1	86.26	40.56	32.91	59.69	15.14	119.0
3	STD#4	94.25	51.38	47.06	50.12	17.92	99.17
1	STD#4	96.88	49.85	45.14	51.32	21.38	99.63
2	STD#4	97.64	56.48	53.46	50.46	20.06	95.97
3	STD#4	89.51	50.70	45.68	49.31	19.04	91.75
4	STD#4	92.30	53.66	46.26	43.77	19.63	96.63
1	FGU-SQ3-1C	10.52	5.790	10.53	25.45	6.076	52.08
2	FGU-SQ3-1C	9.697	4.894	11.38	24.92	6.234	50.88
3	FGU-SQ3-1C	10.45	5.387	11.11	22.51	6.023	56.83
5	STD#4	103.8	< 0.000	48.69	< 0.150	18.74	93.68
6	STD#4	99.48	47.59	46.76	50.29	19.76	86.02
1	CGO-SQ3-1G	40.89	19.38	16.04	28.34	7.253	49.63
2	CGO-SQ3-1G	33.70	18.10	17.80	26.59	6.969	53.28
3	CGO-SQ3-1G	36.49	18.17	15.36	27.18	7.540	49.37
7	STD#4	83.35	55.87	45.34	49.34	19.93	93.09

ANOTHER FILE (Y/N)?

COAL SLURRY 0.812% SOLIDS SI 2124.12

```
STEP  ANG.        INCREMENT =   285.9 COUNTS     FULL SCALE = 17156. COUNTS

              I....I....I....I....I....I....I....I....I....I....I....I....I
-16  2123.62   @
-15  2123.65   @
-14  2123.68   @
-13  2123.71   @
-12  2123.74   @
-11  2123.78   @
-10  2123.81   @
-9   2123.84   @
-8   2123.87   @
-7   2123.90   @
-6   2123.93   @*
-5   2123.96   @*
-4   2123.99   @ *$
-3   2124.03   @     *$
-2   2124.06   @               * $
-1   2124.09   @                                   * $
 0   2124.12   @                                             $     *
 1   2124.15   @                                              $           *
 2   2124.18   @                               $               *
 3   2124.21   @                     $       *
 4   2124.24   @       $     *
 5   2124.28   @  $*
 6   2124.31   @$*
 7   2124.34   @*
 8   2124.37   @$
 9   2124.40   @
10   2124.43   @
11   2124.46   @
12   2124.49   @
13   2124.53   @
14   2124.56   @
15   2124.59   @
16   2124.62   @
              I....I....I....I....I....I....I....I....I....I....I....I....I
```

@ = STD.#1(MATRIX)

* = STD.#4(SECONDARY STD.)

$ = CGO-SC4-1

COAL SLURRY 0.812% SOLIDS AL 3944.03

```
STEP  ANG.       INCREMENT =    34.2 COUNTS     FULL SCALE = 2050.0 COUNTS

              I....I....I....I....I....I....I....I....I....I....I....I....I
-16  3943.53         @$
-15  3943.56         @$
-14  3943.59         @$
-13  3943.62         @$
-12  3943.65         @$
-11  3943.69         @$
-10  3943.72         @$
-9   3943.75         @$
-8   3943.78         @$
-7   3943.81         @$
-6   3943.84         @*
-5   3943.87         @  $
-4   3943.90         @*   $
-3   3943.94         @  *    $
-2   3943.97         @   *             $
-1   3944.00         @    *                         $
 0   3944.03         @     *                                        $
 1   3944.06         @    *                                                $
 2   3944.09         @   *                                    $
 3   3944.12         @   *                    $
 4   3944.15         @*         $
 5   3944.19         @    $
 6   3944.22         @  $
 7   3944.25         @*
 8   3944.28         @*
 9   3944.31         @*
 10  3944.34         @*
 11  3944.37         @*
 12  3944.40         @*
 13  3944.44         @*
 14  3944.47         @*
 15  3944.50         @*
 16  3944.53         @*
              I....I....I....I....I....I....I....I....I....I....I....I....I
```

@ = STD.#1(MATRIX)

* = STD.#4(SECONDARY STD.)

$ = CGO-SC4-1

COAL SLURRY 0.812% SOLIDS FE 2739.55

```
STEP  ANG.        INCREMENT =  304.1 COUNTS     FULL SCALE = 18248. COUNTS

                 I....I....I....I....I....I....I....I....I....I....I....I....I
-16  2739.05       @
-15  2739.08      @*
-14  2739.11      @*
-13  2739.14      @*
-12  2739.17       @
-11  2739.21       @
-10  2739.24      @*
-9   2739.27      @*
-8   2739.30      @*
-7   2739.33       @
-6   2739.36       @
-5   2739.39      @ *
-4   2739.42       @  *
-3   2739.46      @       $ *
-2   2739.49       @                  $       *
-1   2739.52       @                                 $       *
 0   2739.55       @                                        $                *
 1   2739.58       @                                           $        *
 2   2739.61       @                            $       *
 3   2739.64       @                *
 4   2739.67      @   $  *
 5   2739.71       @*
 6   2739.74       @
 7   2739.77       @
 8   2739.80       @
 9   2739.83       @
 10  2739.86       @
 11  2739.89      @*
 12  2739.92      @*
 13  2739.96       @
 14  2739.99      @*
 15  2740.02       @
 16  2740.05       @
                 I....I....I....I....I....I....I....I....I....I....I....I....I
```

@ = STD.#1(MATRIX)

* = STD.#4(SECONDARY STD.)

$ = CGO-SC4-1

COAL SLURRY 0.812% SOLIDS CA 4226.73

```
STEP  ANG.        INCREMENT =  210.7 COUNTS     FULL SCALE = 12642. COUNTS

              I....I....I....I....I....I....I....I....I....I....I....I....I
-16  4226.23    @
-15  4226.26    @
-14  4226.29    @
-13  4226.32    @
-12  4226.35    @
-11  4226.39    @
-10  4226.42    @
 -9  4226.45    @
 -8  4226.48    @
 -7  4226.51    @
 -6  4226.54    @*
 -5  4226.57    @*
 -4  4226.60    @  *
 -3  4226.64    @      *
 -2  4226.67    @               $ *
 -1  4226.70    @                                $ *
  0  4226.73    @                                               * $
  1  4226.76    @                                                   *      $
  2  4226.79    @                                   *       $
  3  4226.82    @                     *     $
  4  4226.85    @       * $
  5  4226.89    @  *
  6  4226.92    @*
  7  4226.95    @*
  8  4226.98    @
  9  4227.01    @
 10  4227.04    @
 11  4227.07    @
 12  4227.10    @
 13  4227.14    @
 14  4227.17    @
 15  4227.20    @
 16  4227.23    @
              I....I....I....I....I....I....I....I....I....I....I....I....I
```

@ = STD.#1(MATRIX)

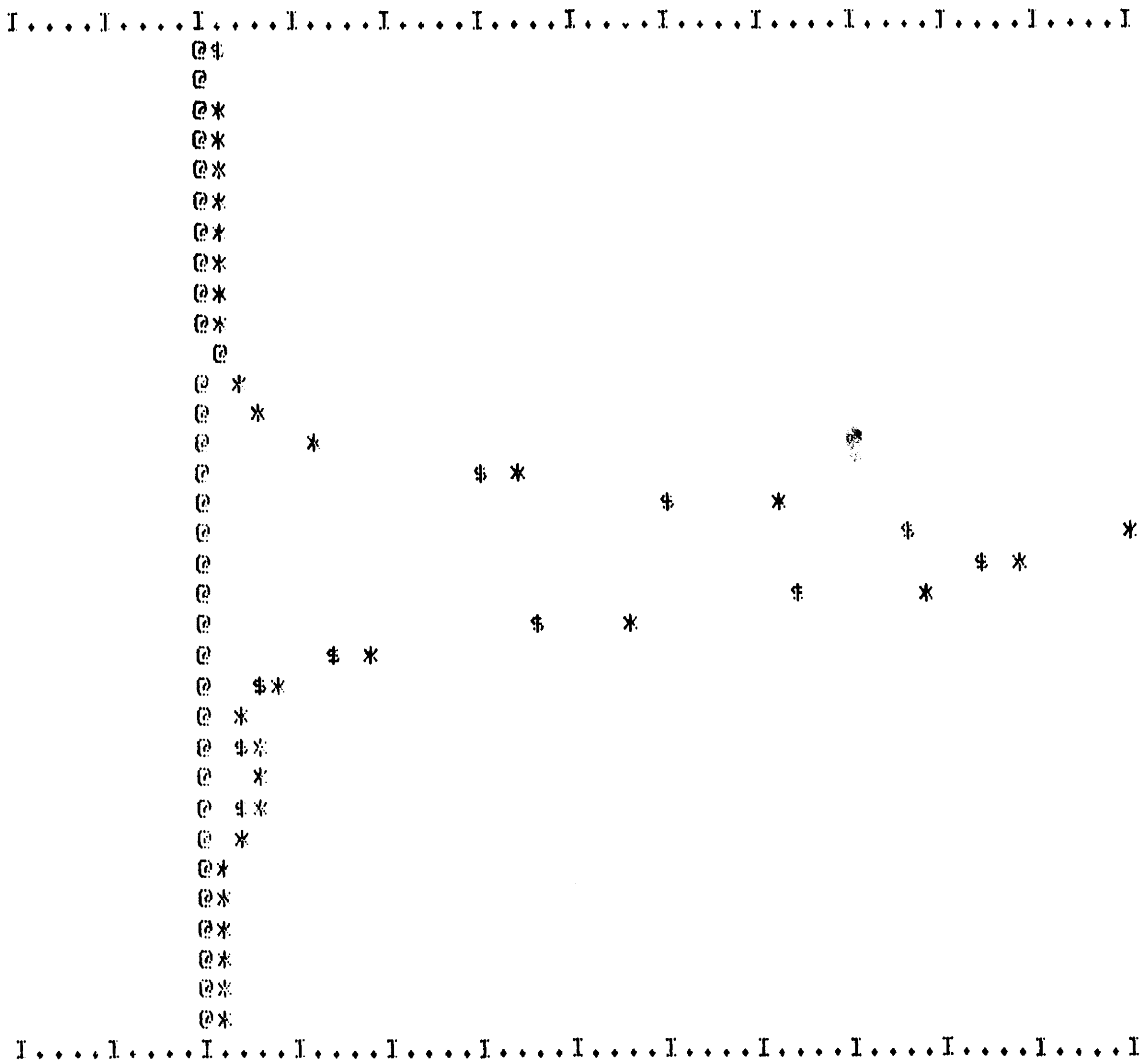
* = STD.#4(SECONDARY STD.)

$ = CGO-SC4-1

COAL SLURRY 0.812% SOLIDS MG 2790.8

STEP ANG. INCREMENT = 18.7 COUNTS FULL SCALE = 1121.0 COUNTS

STEP	ANG.
-16	2790.30
-15	2790.33
-14	2790.36
-13	2790.39
-12	2790.42
-11	2790.46
-10	2790.49
-9	2790.52
-8	2790.55
-7	2790.58
-6	2790.61
-5	2790.64
-4	2790.67
-3	2790.71
-2	2790.74
-1	2790.77
0	2790.80
1	2790.83
2	2790.86
3	2790.89
4	2790.92
5	2790.96
6	2790.99
7	2791.02
8	2791.05
9	2791.08
10	2791.11
11	2791.14
12	2791.17
13	2791.21
14	2791.24
15	2791.27
16	2791.30



@ = STD.#1(MATRIX)

* = STD.#4(SECONDARY STD.)

$ = CGO-SC4-1

COAL SLURRY 0.812% SOLIDS S 1807.31

```
STEP  ANG.        INCREMENT =  235.3 COUNTS     FULL SCALE = 14120. COUNTS

              I....I....I....I....I....I....I....I....I....I....I....I....I
-16  1806.81   @
-15  1806.84   @
-14  1806.87   @
-13  1806.90   @
-12  1806.93   @
-11  1806.97   @
-10  1807.00   @
-9   1807.03   @
-8   1807.06   @
-7   1807.09   @
-6   1807.12   @
-5   1807.15   @
-4   1807.18   @*
-3   1807.22   @$*
-2   1807.25   @$     *
-1   1807.28   @                      $*
 0   1807.31   @                                        *  $
 1   1807.34   @                                                 *       $
 2   1807.37   @                                            *             $
 3   1807.40   @                              *                $
 4   1807.43   @          *        $
 5   1807.47   @  * $
 6   1807.50   @*
 7   1807.53   @
 8   1807.56   @
 9   1807.59   @
10   1807.62   @
11   1807.65   @
12   1807.68   @
13   1807.72   @
14   1807.75   @
15   1807.78   @
16   1807.81   @
              I....I....I....I....I....I....I....I....I....I....I....I....I
```

@ = STD.#1(MATRIX)

* = STD.#4(SECONDARY STD.)

$ = CGO-SC4-1

Dec 4 1990

ICP ANALYSIS OF WATER

PUSH H_2O from 8-1-90

Si	< 1 ppm
Al	< 1 ppm
Fe	< 1 ppm
Ca	410 ppm
Mg	45 ppm
S	690 ppm

CLAR H_2O 8-7-90

Si	<1 ppm
Al	<1 ppm
Fe	<1 ppm
Ca	410 ppm
Mg	44 ppm
S	680 ppm

WELL H_2O 8-7-90

Si	<1 ppm
Al	<1 ppm
Fe	<1 ppm
Ca	82 ppm
Mg	2 ppm
S	689

Dec 3, 1990

ICP ANALYSIS OF WATER

TEST - A DEIONIZED H_2O in plastic bottle

Si <1 ppm
Al <0.5 ppm
Fe <0.5 ppm
Ca <0.5 ppm
Mg <0.2 ppm
S <1 ppm

TEST - B HIGH PURITY H_2O ("MILLI Q") in plastic bottle

Si <1 ppm
Al <0.5 ppm
Fe <0.5 ppm
Ca <0.5 ppm
Mg <0.2 ppm
S <1 ppm

TEST - C HIGH PURITY H_2O + SCRAPPINGS FROM SMALL plastic BOTTLE

Si <1 ppm
Al <0.5 ppm
Fe <0.5 ppm
Ca <0.5 ppm
Mg <0.2 ppm
S <1 ppm

WELL H_2O SAMPLE TAKEN 1635HRS 7·30·90

Si 3.3 ppm
Al <0.5 ppm
Fe <0.5 ppm
Ca 18.1 ppm
Mg 6.0 ppm
S 665 ppm

ICP Analysis of Filtrates

	ppm Si	ppm Al	ppm Fe	ppm Ca	ppm Mg	ppm S
FGU-SC4-1	0.90	<0.5	<0.5	47.2	14.6	131
FGU-SC4-2	1.1	0.52	<0.5	51.4	14.8	128
FGU-SC4-3	1.1	0.56	<0.5	55.8	14.3	128
FGU-SC4-4	0.80	0.50	0.52	60.6	14.9	132
FGU-SC4-5	1.0	0.55	<0.5	60.7	14.1	128
FGU-SC4-6	1.0	0.60	<0.5	63.9	13.8	133
FGU-SC4-7	0.82	0.70	0.60	62.1	14.3	139
CGO-SC4-3	<0.5	<0.5	<0.5	68.2	13.8	114
CGO-SC4-4	<0.5	<0.5	<0.5	66.9	12.8	112
CGO-SC4-5	<0.5	<0.5	<0.5	60.7	12.1	106
CGO-SC4-6	<0.5	<0.5	<0.5	56.2	10.5	92.4
CGO-SC4-7	<0.5	<0.5	<0.5	65.1	12.1	109
CGO-SC4-8	<0.5	<0.5	<0.5	68.2	11.8	106
CGO-SC4-9	<0.5	<0.5	<0.5	65.5	12.6	112
CGO-SC4-10	<0.5	<0.5	<0.5	61.9	10.5	99.8
CGO-SC4-11	<0.5	<0.5	<0.5	52.2	10.5	98.5
CGO-SC4-12	<0.5	<0.5	<0.5	51.8	10.5	99.8

Tank # 42 wet mud

BABCOCK & WILCOX

ICP ANALYSIS OF FILTRATES

		ppm Si	ppm Al	ppm Fe	ppm Ca	ppm Mg	ppm S
	FGU-SC4-1	0.90	<0.5	<0.5	47.2	14.6	131
	FGU-SC4-2	1.1	0.52	<0.5	51.4	14.8	128
	FGU-SC4-3	1.1	0.56	<0.5	55.8	14.3	128
	FGU-SC4-4	0.80	0.50	0.52	60.6	14.9	132
	FGU-SC4-5	1.0	0.55	<0.5	60.7	14.1	128
	FGU-SC4-6	1.0	0.60	<0.5	63.9	13.8	133
	FGU-SC4-7	0.82	0.70	0.60	62.1	14.3	139
	CGO-SC4-3	<0.5	<0.5	<0.5	68.2	13.8	114
	CGO-SC4-4	<0.5	<0.5	<0.5	66.9	12.8	112
	CGO-SC4-5	<0.5	<0.5	<0.5	60.7	12.1	106
	CGO-SC4-6	<0.5	<0.5	<0.5	56.2	10.5	92.4
	CGO-SC4-7	<0.5	<0.5	<0.5	65.1	12.1	109
	CGO-SC4-8	<0.5	<0.5	<0.5	68.2	11.8	106
	CGO-SC4-9	<0.5	<0.5	<0.5	65.5	12.6	112
	CGO-SC4-10	<0.5	<0.5	<0.5	61.9	10.5	99.8
	CGO-SC4-11	<0.5	<0.5	<0.5	52.2	10.5	98.5
	CGO-SC4-12	<0.5	<0.5	<0.5	51.8	10.5	99.8
x	FGU-SC4-8	1.2	0.7	<0.5	64.0	13.9	135
x	CGO-SC4-1	0.70	<0.5	<0.5	60.6	13.1	110
x	CGO-SC4-2	0.74	<0.5	<0.5	61.8	12.8	103

ICP ANALYSIS OF FILTRATES

	ppm Si	ppm Al	ppm Fe	ppm Ca	ppm Mg	ppm S
alibration spl. CGO-SQ3-1G-1	<0.5	<0.5	<0.5	27.0	5.1	46.8
alibration spl FGU-SQ3-1C-1	<0.5	<0.5	<0.5	25.4	5.9	56.6
F-4630 CGO-SQ3'-1A	1.4	1.6	<0.5	206	41.9	361
F-4631 FGU-SQ3'-1G	2.3	1.8	0.94	124	29.6	280
WELL H_2O 8-7	3.5	<0.5	<0.5	22.8	5.30	739
CLAR H_2O 8-7	1.2	3.3	<0.5	449	39.8	696
PUSH H_2O 8-1-90	1.6	3.6	<0.5	477	46.3	749
DEION. H_2O TEST-A	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hi PURITY H_2O TEST-B	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SCRAPPED FROM SMALL BORE TEST-C	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

APPENDIX H

HOMER CITY COAL LAB PROCEDURES

Homer City Coal Laboratory

P.O. BOX 29 • HOMER CITY, PA 15748 • (412) 479-9011

December 20, 1990

Mr. Mike Milito
Babcock and Wilcox Research
1562 Beeson Street
Alliance, OH 44601

Dear Mike,

Attached find uncontrolled copies of HCCL procedures you requested on 12/18/90. They are:

- HCL-101, Ash Content.
- HCL-102, Residual Moisture in Coal.
- HCL-106, Determination of Elements in Coal Ash.
- HCL-204, Suspended Solids.

HCCL technicians filtered the four B&W reference samples at the CQ Inc. facility. We filtered these samples using two vat bags with five, 50 cm Whatman #541 filter papers between them. Whatman #541 paper has a retention rating between 20 and 25 microns.

All remaining B&W samples were filtered using 9.0 cm Whatman #42 paper in a Buchner filtration assembly. The Buchner assembly replaced the Denver filtration assembly because of the small sample size. Whatman #42 paper has a retention rating of 2.5 microns.

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The following table lists the HCCL sample number, the date received, the date filtered, and the filter paper used.

HCCL Sample No.	Date Received	Date Filtered	Filter Type
900800004	07/31/90	08/01/90	Whatman #541, 50 cm. *
900800005	07/31/90	08/01/90	Whatman #541, 50 cm. *
900800006	07/31/90	08/08/90	Whatman #42, 9 cm.
900800007	07/31/90	08/08/90	Whatman #42, 9 cm.
900800008	07/31/90	08/08/90	Whatman #42, 9 cm.
900800009	07/31/90	08/08/90	Whatman #42, 9 cm.
900800010	07/31/90	08/08/90	Whatman #42, 9 cm.
900800011	07/31/90	08/08/90	Whatman #42, 9 cm.
900800012	07/31/90	08/08/90	Whatman #42, 9 cm.
900800013	07/31/90	08/08/90	Whatman #42, 9 cm.
900800014	07/31/90	08/08/90	Whatman #42, 9 cm.
900800037	08/02/90	08/03/90	Whatman #541, 50 cm. *
900800038	08/02/90	08/16/90	Whatman #42, 9 cm.
900800039	08/02/90	08/16/90	Whatman #42, 9 cm.
900800040	08/02/90	08/16/90	Whatman #42, 9 cm.
900800041	08/02/90	08/16/90	Whatman #42, 9 cm.
900800042	08/02/90	08/16/90	Whatman #42, 9 cm.
900800043	08/02/90	08/16/90	Whatman #42, 9 cm.
900800044	08/02/90	08/16/90	Whatman #42, 9 cm.
900800045	08/02/90	08/16/90	Whatman #42, 9 cm.
900800046	08/02/90	08/16/90	Whatman #42, 9 cm.
900800047	08/02/90	08/16/90	Whatman #42, 9 cm.
900800048	08/02/90	08/16/90	Whatman #42, 9 cm.
900800049	08/02/90	08/16/90	Whatman #42, 9 cm.
900800170	08/09/90	08/09/90	Whatman #541, 50 cm. *
900800171	08/09/90	08/16/90	Whatman #42, 9 cm.
900800172	08/09/90	08/16/90	Whatman #42, 9 cm.

* - Samples filtered @ CQ Inc. using two vat bags with 5 of these filters between them.

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Please contact me if you need any additional information.

Sincerely,

David M. Glessner

David M. Glessner
HCCL Laboratory Manager
Geochemical Testing/ECI

Attachments

cc: D. J. Seigh (w/o attachments)
S. L. McClintock (w/o attachments)

Penelec / GPU	HOMER CITY LABORATORY
TITLE: ASH CONTENT	
PROCEDURE NO: HCL-101	REVISION DATE: 03/28/90
COPY NO:	REVISION NO: 5
PAGE 1 OF 11	EFFECTIVE DATE:

TABLE OF REVISIONS

PAGE	DATE	REV.	PAGE	DATE	REV.	PAGE	DATE	REV.
1	03/28/90	5						
2	03/28/90	3						
3	03/28/90	5						
4	03/28/90	5						
5	03/28/90	5						
6	03/28/90	5						
7	03/28/90	5						
8	03/28/90	4						
9	03/28/90	4						
10	03/28/90	5						
11	03/28/90	0						

ORIGINATOR: DM Glessner	DATE: 03/28/90
APPROVAL: David M Glessner	DATE: 03/29/90
AUTHORIZATION FOR LAB USE:	DATE:

REAPPROVED:	DATE:

CANCELED:	DATE:

1.0 REFERENCES

1.1 Annual Book of ASTM Standards, Method D3174-89, "Ash in the Analysis Sample of Coal and Coke From Coal."

1.2 Annual Book of ASTM Standards, Method D121-85, "Standard Definitions of Terms Relating to Coal and Coke."

1.3 Fisher Oven Model 497 Instruction Manual.

1.4 Method HCL-1001, "Preparation of Technical Procedures."

1.5 Method HCL-230, "Preparation of a Coal Sample."

1.6 Method HCL-102, "Residual Moisture."

1.7 Method HCL-119, "Percent Magnetic Material."

1.8 Method HCL-144, "Correcting Analytical Results for Magnetic Material."

1.9 Method HCL-182, "Percent SO_3 in Coal Ash By Leco SC-32 Analyzer."

2.0 SCOPE AND APPLICATION

2.1 This method describes the procedure for determining the inorganic residue as ash in coal.

2.2 This method is applicable to all samples prepared in accordance with Section 6.0 of this procedure.

2.3 The sensitivity of this method is equal to the sensitivity of the balance. If an AC-100 or AE-160 balance is used, the sensitivity is 0.10 percent ash.

2.4 The precision of this method at HCCL represents the difference between replicate ash results on the same prepared coal sample. The difference in test results, carried out by the same operator should not exceed 0.24 percent. This precision interval is at 95 percent confidence using Quality Assurance data from July through December, 1989.

2.5 The accuracy of this method at HCL represents the difference between the test result and the standard ash value of a control sample. The difference from the standard value should not exceed 0.30 percent. This accuracy interval is at 95 percent confidence using Quality Assurance data from July through December, 1989.

2.6 Ash values from this method can be applied in the proximate analysis and the ultimate analysis. See ASTM D121.

2.7 Results from this method can be used to correct other parameters to a mineral-matter-free basis.

2.8 Ash content from this method can be used for payment purposes, to monitor emission standards, to evaluate sampling processes, to determine the effectiveness of coal cleaning processes, and to classify coal by rank.

3.0 SUMMARY OF METHOD

3.1 Ash is determined on a one gram sample under rigidly controlled conditions of time, temperature, atmosphere, and equipment specifications. The amount of residue remaining after ignition represents the ash content.

4.0 DEFINITIONS

4.1 Ash - The inorganic residue remaining in the sample after ignition of combustible substances when heated under controlled conditions of temperature, time and atmosphere, sample weight, and equipment specifications.

4.2 High Rank Coals - For the purpose of this procedure, anthracite, semi-anthracite, and bituminous coals.

4.3 Low Rank Coals - For the purpose of this procedure, subbituminous and lignite coals.

5.0 INTERFERENCES

5.1 Clays, carbonates, and pyrites lower ash results by causing a loss in weight from the original inorganic materials.

5.2 Calcium carbonate, in the presence of high sulfur concentrations, undergoes a chemical reaction that retains sulfur as calcium sulfate. High ash values are the result. Nominal concentrations of calcium sulfate are minimized by the slow heat rate used in this procedure. Low rank samples, which contain high amounts of calcium sulfate, are ashed for an additional hour and analyzed for SO_3 retention in accordance with HCL-182. See Section 13.2 for correcting ash values to a SO_3-free basis.

5.3 Magnetite in the sample will yield high ash results. The percent magnetic material is determined in accordance with HCL-119. Ash results are corrected to a non-mag basis as outlined in HCL-144.

6.0 SAMPLE HANDLING AND PRESERVATION

6.1 All samples of coal are prepared and containerized in accordance with HCL-230.

6.2 Samples shall be well mixed before analysis.

6.3 Samples that require correction for SO_3 retention in ash are handled in accordance with HCL-182.

6.4 Samples that require correction for magnetic material in ash are handled in accordance with HCL-119 and HCL-144.

6.5 Unless otherwise requested, coal samples are maintained in inventory 90 days after report date and then discarded.

7.0 PREREQUISITES

7.1 The furnace must be programmed for the correct temperature, temperature rates, and holding times.

7.1.1 Press the PARAMETER SET key.

7.1.2 Enter the following conditions for high rank coals:

* R1: 7 (degrees C/min).
* T1: 450 (degrees C).
* H1: 0.
* R2: 5 (degrees C/min).
* T2: 750 (degrees C).
* H2: 120 (minutes).

Set the remaining heating and cooling temperatures, rates, and hold times to "0".

7.1.3 Enter the following conditions for low rank coals:

* R1: 7 (degrees C/min).
* T1: 450 (degrees C).
* H1: 0.
* R2: 5 (degrees C/min).
* T2: 750 (degrees C).
* H2: 160 (minutes).

Set the remaining heating and cooling temperatures, rates, and hold times to "0".

7.1.4 Enter the following conditions for quick ash analysis:

* R1: 35 (degrees C/min).
* T1: 450 (degrees C).
* H1: 10 (minutes).
* R2: 35 (degrees C/min).
* T2: 750 (degrees C).
* H2: 25 (minutes).

Set the remaining heating and cooling temperatures, rates, and hold times to "0".

7.1.5 Enter the following conditions for low ash coals:

* R1: 7 (degrees C/min).
* T1: 450 (degrees C).
* H1: 0.
* R2: 5 (degrees C/min).
* T2: 750 (degrees C).
* H2: 270 (minutes).

Set the remaining heating and cooling temperatures, rates, and hold times to "0".

7.2 The furnace must be checked and adjusted if necessary (see Section 10.1).

7.3 The analytical balance must be checked for calibration before use.

7.4 Sample crucibles must be dried at 105 degrees Celsius for one hour and then cooled to room temperature in a desiccator before analysis.

7.5 Sample sets must be generated by laboratory computer system.

8.0 <u>APPARATUS</u>

8.1 Fisher Ash Oven Model 497.

8.1.1 Refer to the 497 Instruction Manual for the oven's performance characteristics and specifications.

8.2 Crucibles, porcelain - 22.5ml capacity, 41 x 21mm rounded and glazed bottom.

8.3 Crucible racks and rack handles for 8.2.

8.4 Mettler AC-100 balance (see HCL-180) or equivalent.

8.5 Desiccators with desiccant columns.

8.6 Pyrometer.

8.7 Crucible tongs.

8.8 Furnace gloves.

9.0 <u>REAGENTS</u>

9.1 Silica Gel (8 to 16 mesh) drying agent.

10.0 CALIBRATION

10.1 Furnace Calibration.

10.1.1 Furnace calibration checks are done on a monthly basis or when a potential problem is suspected.

10.1.2 Place a crucible half full with sand on the top shelf directly underneath the outlet port hole.

10.1.3 Enter the correct parameter settings and turn the furnace ON. Wait until the furnace reaches the final temperature of 750 degrees Celsius.

10.1.4 Insert the pyrometer into the outlet port hole so that the pyrometer probe is in sand. Read the temperature. If the thermometer reading exceeds the required temperature range (750 ±50 degrees celsius), increase or decrease the parameter set control until the pyrometer is in the required temperature range.

10.2 Balance Calibration.

10.2.1 Refer to the balance technical procedure or balance operator's manual.

11.0 TRAINING

11.1 Condition - Technicians shall weigh and analyze a minimum of 20 ash determinations (5 runs on 4 samples). The amount of time should not exceed 1.5 manhours. Technicians shall calculate percent ash correctly and tabulate the average and standard deviation for each series.

11.2 Standard - The equivalent precision from the standard deviation from 11.1 shall be no more than 0.50 percent ash.

SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	RECOMMENDED PRACTICES
12.0 PROCEDURE		
12.1 Tare the balance to zero.	Incorrect weight.	The balance should be checked for calibration before analysis.
12.2 Place a dry, cool crucible from the desiccator on the balance pan.	Moisture contamination.	Use forceps - do not touch the crucible with your hands.
	Sample was weighed and dried in accordance with HCL-102.	Use crucible and initial coal weight from HCL-102 and proceed to step 12.8.
12.3 Determine the weight of the crucible to the nearest 0.0001 gram. Record this weight on the data sheet (see Appendix I).	Sample mix-up.	Record crucible ID in the appropriate column.
12.4 With the crucible still on the balance, tare the balance to zero.	Inconsistent results.	Do this step slowly. Failure to tare the balance correctly will yield erratic results.
12.5 Hand mix the sample and weigh between 0.9750 to 1.0050 grams into the crucible. Record the sample weight (see Appendix I).	Low ash (less than 1%) coals.	Weigh the sample at 5.0 grams in duplicate. Use steps 12.1.8 through 12.1.10 to determine ash but analyze these samples separately. They require a final furnace temperature hold time of 270 minutes (see 7.1.5).
	Quick ash analysis.	Weigh the sample at 0.2 ±0.0050 grams. Section 7.1.4 lists the parameter settings.

SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	RECOMMENDED PRACTICES
12.5 (continued).	Particle segregation.	Mix the sample by rolling the jar end over end.
	Sample spillage.	Brush off any material from the balance so that it does not contribute to the initial sample weight.
12.6 Repeat steps 12.1 through 12.5 for each sample in the set.	See 12.1 through 12.5.	See 12.2 through 12.5.
12.7 Repeat steps 12.1 through 12.5 for the duplicate sample and control sample.	See 12.1 through 12.5.	See 12.2 through 12.5.
12.8 Place the samples into a crucible rack. Transfer the samples into the furnace. Turn the furnace and furnace fan on. The furnace sounds an alarm when the ash program is complete.	Deviating from parameter conditions.	Always check the parameter settings. If they were incorrect while testing, repeat the analysis. The furnace temperature must be below 200 degrees C before samples can be transferred into the furnace. Check to assure that the furnace fan and the oven heat ramp is operating.
	Low rank samples.	Require an additional hour for ash analysis (see 7.1.3).
	Quick ash samples.	The furnace may give an alarm due to the rapid temperature rate. If this occurs, press the CLEAR key and restart the program.
	Incorrectly inserting the rack.	The rack goes into the furnace with handle hole facing you.

SAFE JOB PROCEDURE

SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	RECOMMENDED PRACTICES
12.9 When the ash program is complete, remove the sample racks from the furnace. Allow about 5 minutes for the racks to cool in the open air on a fire brick. When the racks are cool enough for safe transfer, insert the racks into a desiccator to cool.	Burns.	Use safety gloves, and the rack handle. Extension tongs are also available.
	Moisture gain.	Place capsule lids over the crucibles.
12.10 Tare the balance and place a crucible containing the ashed residue on the balance pan. Record the weight (see Appendix I).		
12.11 Repeat step 12.10 for each sample in the set.	Low ash samples.	After weighing, return the samples to the furnace for an additional 30 minutes. Repeat steps 12.8 through 12.10. Compare second weight with the initial weight. If they differ by more than ±0.0005 grams, repeat this step until this criterion is met.
	Low rank samples.	Save ash for determining the SO_3 retention.

13.0 CALCULATIONS

13.1 Percent ash is found by the equation:

$$A = [(D - C)/B] \times 100$$

where: A = percent ash.
B = coal weight (grams).
C = crucible weight (grams).
D = crucible plus residue weight (grams).

13.2 Percent ash corrected to a SO_3-free basis is found by the equation:

$$F = A - [A(E/100)]$$

where: A = percent ash from 13.1.
E = percent SO_3 from HCL-182.
F = percent SO_3-free ash.

13.3 Percent loss on ignition is found by the equation:

$$G = 100 - A$$

where: A = percent ash from 13.1.
G = percent loss on ignition (LOI).

14.0 ACCEPTANCE CRITERIA

14.1 In Lab Precision - Duplicate results analyzed at HCCL should be considered suspect unless they differ by more than:

* 0.30 percent on anthracite coals.
* 0.50 percent on semi-anthracite and bituminous coals.
* 0.70 percent on subbituminous coals and flyash.
* 1.00 percent on lignite coals.

14.2 Interlaboratory Precision - Results submitted by two or more laboratories should be considered suspect unless they differ by more than:

* 0.40 percent on anthracite coals.
* 0.60 percent on semi-anthracite and bituminous coals.
* 1.00 percent on subbituminous coals and flyash.
* 2.00 percent on lignite coals.

APPENDIX I

Sample Data Sheet

PENNSYLVANIA ELECTRIC COMPANY
HOMER CITY LABORATORY

ASH ANALYSIS

SET NUMBER: 80412 011

LINE NO.	SAMPLE NUMBER	LAB NO.	CRUC ID	CRUCIBLE WEIGHT	SAMPLE WEIGHT	CRUCIBLE & SAMPLE DRY	CRUCIBLE & ASH	PER CENT MOISTURE	PER CENT ASH
	A	B	C	D	E	F	G	H	I
1	890300257	003							
2	890300257	004							
3	890300258	022							
4	890300258	023							
5	890300258	024							
6	890300258	025							
7	890300258	026							
8	890300258	027							
9	890300258	028							
10	890300259	013							
11	890300259	014							
12	890300259	015							
13	890300259	016							
14	890300259	017							
15	890300259	018							
16	890300259	019							
17	890300259	020							
18	890300309	002							
19									
20									

LAB TEMP: ________ HUMIDITY: ________ ASH OVEN ID: ________ ANALYST: ________ DATE: ________

Penelec / GPU	HOMER CITY LABORATORY
TITLE: Residual Moisture in Coal	
PROCEDURE NO: HCL-102	REVISION DATE: 10/31/89
COPY NO:	REVISION NO: 4
PAGE 1 OF 10	EFFECTIVE DATE: JAN 22 1990

TABLE OF REVISIONS

PAGE	DATE	REV.	PAGE	DATE	REV.	PAGE	DATE	REV.
1	10/31/89	4						
2	10/31/89	3						
3	10/31/89	3						
4	10/31/89	4						
5	10/31/89	3						
6	10/31/89	3						
7	10/31/89	3						
8	10/31/89	3						
9	10/31/89	0						
10	10/31/89	0						

ORIGINATOR: D M Glessner	DATE: 10/31/89
APPROVAL: David M. Glessner	DATE: 11/6/89
AUTHORIZATION FOR LAB USE: Donald J. Seigh	DATE: 1-22-90

REAPPROVED:	DATE:

CANCELED:	DATE:

1.0 REFERENCES

1.1 Annual Book of ASTM Standards, Method D3173-87, Moisture in the Analysis Sample of Coal and Coke.

1.2 Fisher Oven Model 496 Instruction Manual.

1.3 Method HCL-1001, "Preparation of Technical Procedures."

1.4 Method HCL-230, "Preparation of a Coal Sample."

2.0 SCOPE AND APPLICATION

2.1 This method describes the procedures for determining the residual moisture of coal and coke.

2.2 This method is applicable to all samples prepared in accordance with section 6.0 of this procedure.

2.3 The sensitivity of this method is equal to the sensitivity of the balance. If an AC-100 or AE-160 balance is used, the sensitivity is 0.10 percent moisture.

2.4 The precision of determining residual moisture at HCCL represents the difference between replicate test results on the same prepared coal sample. At 95 percent confidence, the difference in test results carried out by the same operator should differ by no more than 0.12 percent on a sample with a residual moisture content of about 0.60 percent. This precision interval is based on Quality Assurance data from January through June, 1989.

2.5 The accuracy of determining residual moisture at HCCL represents the difference between the test result and the standard value of a control sample. At 95 percent confidence, this difference should be no more than 0.28 percent on a control sample with a residual moisture content of about 1.05 percent. This accuracy interval is based on reported Quality Assurance data from January through June, 1989. It assumes that residual moisture in the control sample does not change, but the actual nature of residual moisture shows that this is not the case. In addition, environmental conditions such as temperature and humidity, along with the depletion of the control sample, may cause a systematic error in the accuracy of this test.

2.6 Determining the residual moisture is used to calculate other analytical results to a dry basis. The residual moisture is not a significant value for interpretation, but rather, a step in analytical procedure. The residual moisture can represent the total moisture when no air dry loss is performed.

3.0 SUMMARY OF METHOD

3.1 Moisture is determined on a one gram sample of coal at a temperature between 104 and 110 degrees celsius for one hour. The oven used for determining moisture has an air exchange of three volumes per minute. The weight loss after drying represents the residual moisture content.

4.0 DEFINITIONS

4.1 Residual Moisture - The moisture remaining in the sample after drying when heated under specified conditions of temperature, time and atmosphere, sample weight, and equipment specification.

5.0 INTERFERENCES

5.1 Moist air as the drying medium will yield low results. The freeze drying unit and desiccant should be checked once per day to assure proper operation.

6.0 SAMPLE HANDLING AND PRESERVATION

6.1 All samples of coal are prepared and containerized in accordance with HCL-230.

6.2 All samples shall be well mixed before analysis.

6.3 Unless stated otherwise, coal samples are maintained in inventory 90 days after report date and then discarded.

7.0 PREREQUISITES

7.1 The oven must be at the correct temperature before analysis (see section 10.1).

7.2 The oven must be connected to the house air. The house air must go to the freeze drying unit (section 8.3) and two columns of silica gel.

7.3 The oven timer must be set to the correct time.

7.3.1 Press the TIME SET switch and simultaneously press the FAST switch to advance the DRYING TIME display.

7.3.2 When the time display approaches the desired time (1 hour and 15 minutes), quickly release the FAST switch and press the SLOW switch until you reach the desired time. The "set time" is now entered, release the SET TIME switch.

7.4 The inlet port (rear most port) must be completely closed and the outlet port must be completely opened.

7.5 Sample crucibles must be dried at 105 degrees Celsius for one hour and then cooled to room temperature on a desiccator before analysis.

7.6 Sample sets must be generated by laboratory computer system.

8.0 APPARATUS

8.1 Fisher Ash Oven Model 496 (see Appendix II).

8.1.1 Refer to the 496 Instruction Manual for the oven's performance characteristics and specifications (pages 5 - 8).

8.2 Crucibles, porcelain - 22.5ml capacity, 41 x 21mm rounded and glazed bottom.

8.3 Crucible racks for Fisher oven.

8.4 Mettler AC-100 balance (see HCL-180) or equivalent.

8.5 Desiccators.

8.6 Freeze Drying Unit - Specifications.

Pressure: 200 psig max.
Temperature: inlet air 130 degrees C.
ambient air 50 degrees C min.; 100 degrees C max.
Flow Rate: 5, 10, 15 SCFM
Dewpoint: 33 to 39 degrees Fahrenheit.

8.7 House air - for renewing the preheated air in the oven at a rate three times per minute.

8.8 ASTM thermometer - temperature range 95 to 155 degrees Celsius.

8.9 Desiccant columns.

9.0 REAGENTS

9.1 Silica Gel (8 to 16 mesh) drying agent.

10.0 CALIBRATION

10.1 Oven Calibration.

10.1.1 Press READ switch to the right and simultaneously turn the set control (CW for increase) until the display shows the desired "set temperature" (104 - 110 degrees Celsius).

10.1.2 Insert the thermometer into the outlet port hole and read the temperature. If the thermometer reading exceeds the required temperature range (104 - 110 degrees Celsius), adjust the set control in accordance with 10.1.1 until the thermometer is in the required temperature range.

10.2 Balance Calibration.

10.2.1 Refer to technical procedure HCL-180.

11.0 TRAINING

11.1 Condition - Technicians must determine a minimum of 20 moisture runs (5 runs on 4 samples) within 3 hours. All results must be calculated correctly and tabulated with an average and standard deviation for each series.

11.2 Standards - The equivalent precision from the standard deviation from 11.1 shall be no more than 0.20 percent for each sample analyzed.

SAFE JOB PROCEDURE

Procedure No: HCL-102 Revision Date: 10/31/89 Revision No: 3

SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	RECOMMENDED PRACTICES
12.0 PROCEDURE		
12.1 Tare the balance to zero.	Incorrect weight.	The balance should be checked for calibration before analysis.
12.2 Place a dry, cool crucible from the desiccator on the balance pan.	Moisture contamination.	Use forceps - do not touch the crucible with your hands.
12.3 Determine the weight of the crucible to the nearest 0.0001 gram. Record this weight on the data sheet (see Appendix I).	Sample mix-up.	Record crucible ID.
12.4 With the crucible still on the balance, tare the balance to zero.	Inconsistent results.	Do this step slowly. Failure to tare the balance correctly will yield erratic results.
12.5 Hand mix the sample and weigh between 0.9750 to 1.0050 grams into the crucible. Record the sample weight (see Appendix I).		
12.6 Repeat steps 12.1 through 12.5 for each sample in the set.		
12.7 Repeat steps 12.1 through 12.5 for the duplicate sample and control sample.		
12.8 Transfer the samples into the oven. Turn the timer on and dry the samples for 1 hour and 15 minutes.	Incomplete drying.	It takes the oven 15 minutes to return to a temperature of 104 to 110 degrees celsius once the oven door has been opened. The drying time is 1 hour at the specified temperature.

SAFE JOB PROCEDURE

Procedure No: HCL-102 Revision Date: 10/31/89 Revision No: 3

SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	RECOMMENDED PRACTICES
12.9 Transfer the samples into the desiccator and cool the samples for 20 minutes.	Moisture gain.	Quickly place capsule lids over the crucibles before transferring the samples into the desiccator.
12.10 Tare the balance and place a crucible containing the dried sample on the balance pan. Record the weight. (see Appendix I).		
12.11 Repeat step 12.10 for each sample in the set.		

13.0 CALCULATIONS

13.1 Percent residual moisture is found by the equation:

$$M = [(A + B - C)/B] \times 100$$

where: M = percent residual moisture
A = crucible weight (grams)
B = coal weight (grams)
C = crucible and dry weight (grams)

14.0 ACCEPTANCE CRITERIA

14.1 In Lab Precision - Duplicate results analyzed at HCCL should be no more than 0.20 percent for coals having less than 5 percent moisture and 0.30 percent for coals having more than 5 percent moisture. Results should not be considered suspect unless these criteria are not met.

14.2 Interlaboratory precision of two or more laboratories on a 60M sample should not exceed 0.30 percent on coals having less than 5 percent moisture and 0.50 percent for coals having more than 5 percent moisture.

APPENDIX I

Sample Data Sheet

Penelec / GPU

HOMER CITY LABORATORY
Pennsylvania Electric Company
ASH AND MOISTURE ANALYSIS

DATA SHEET CODE 01

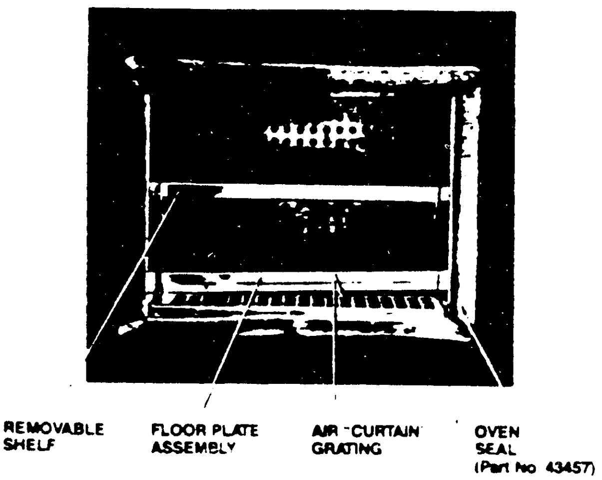
Set Number________

LINE NO.	SAMPLE NO.	LAB NO.	CRUC NO.	CRUCIBLE WEIGHT	CRUCIBLE & SAMPLE WET (g)	CRUCIBLE & SAMPLE DRY (g)	CRUCIBLE & ASH (g) FIRST	CRUCIBLE & ASH (g) SECOND	% MOISTURE	% ASH
	A	B	C	D	E	F	G	H	I	J
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

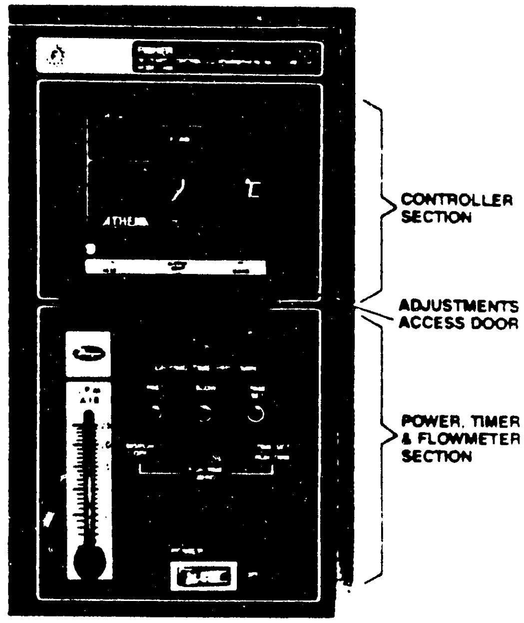
Operator No. ________________ Analyst________________ Date ________

APPENDIX II

Oven Components Identification

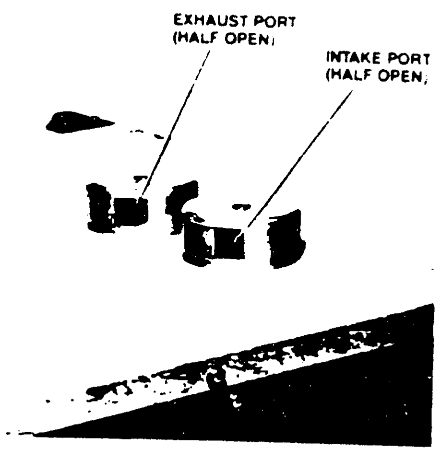


OVEN CHAMBER

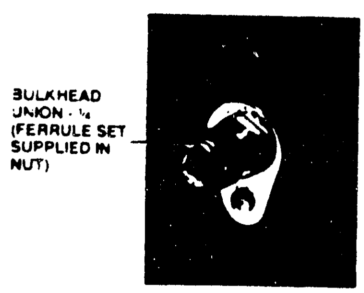


NOTE: THERE MAY BE SLIGHT DIFFERENCES IN NOMENCLATURE BETWEEN PRODUCTION MODELS AND THIS ILLUSTRATION.

FRONT PANEL



EXHAUST AND INTAKE PORTS



REAR PANEL

Penelec / GPU	HOMER CITY LABORATORY
TITLE: DETERMINATION OF ELEMENTS IN COAL ASH	
PROCEDURE NO: HCL-106	REVISION DATE: 11/21/86
COPY NO:	REVISION NO: 7
PAGE 1 OF 18	EFFECTIVE DATE:

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15	07/19/85	2						

ORIGINATOR: D.M. Glessner	DATE: 11/21/86
APPROVAL: Thomas A. [illegible]	DATE: 12/02/86
AUTHORIZATION FOR LAB USE: [illegible]	DATE: 12/11/86

REAPPROVED:	DATE:

CANCELED:	DATE:

1.0 REFERENCES

1.1 ASTM, 1982 Annual Book of ASTM Standards, Part 26, Method D3682-78, "Standard Test Method for Major and Minor Elements in Coal and Coke Ash by Atomic Absorption"; pp. 419-426.

1.2 Evaluation of the Effect of Coal Cleaning on Fugitive Elements, Bituminous Coal Research Report L-1083, March, 1980; pp. 129-143.

1.3 "Preparation of Technical Procedures", Administrative Manual, HCL-1001.

1.4 "Determination of Percent Ash", Technical Manual, HCL-101.

2.0 SCOPE AND APPLICATION

2.1 This procedure is applicable to the preparation of samples received for analysis of major elements in coal ash.

2.2 It is applicable to all coal ranks and types received at HCCL.

2.3 Samples prepared by this method can be expected to yield results within the reproducibility and repeatability ranges reported in ASTM D3682-78 when analyzed properly. (Reference Section 14.0, Table 1).

2.4 Statements of sensitivity are not applicable.

3.0 SUMMARY OF METHOD

3.1 A 60 mesh coal sample is mixed and ashed in sufficient quantity to yield a minimum of 1.500 grams of ash residue. This ash is mixed with an excess of Lithium Metaborate and the mixture fused at 900°C for forty minutes. The resulting melt is digested with dilute nitric acid and quantitatively prepared for spectrophotometric analysis of the metals.

4.0 DEFINITIONS

4.1 Melt is used to refer to the bead-shaped product after fusion of the coal ash with metaborate.

4.2 Spectrophotometric is used to refer to the method of analysis. All elements with the exception of SO_3 and P_2O_5 and determined by Atomic Absorption techniques. SO_3 is determined by the Leco SC-32 and P_2O_5 is determined by UV-VIS techniques.

4.3 A.A. is substituted for atomic absorption spectrophotometer.

4.4 UV-VIS is substituted for Ultra-Violet-Visible Spectrophotometer.

4.5 Ash is substituted for the residue remaining after preparation of the coal by HCL-101.

4.6 Stock Solution is the solution which results from dilution of the melt and the quantitative transfer of this solution to a volumetric flask. This is the solution from which all dilutions are made.

4.7 Analysis Solution is prepared from the stock solution for analysis of an analyte.

4.8 Repeatability is the expected precision of results obtained from the duplicate analysis of a sample performed in the same laboratory by the same technician.

4.9 Reproducibility is the expected precision of results obtained from the duplicate analysis of a sample performed by two different laboratories.

5.0 INTERFERENCES

5.1 Magnetite is considered an interference where magnetite-free analyses are requested. In these cases, a non-magnetic analyses sample is isolated in accordance with HCL-119, "Percent Magnetic Material in Coal" prior to ashing.

6.0 SAMPLE HANDLING AND PRESERVATION

6.1 All analysis samples of coal are prepared and containerized according to HCL-230.

6.2 Ash samples are ground to pass a 200 mesh screen and then mixed with an excess of metaborate.

6.3 Digestion of the melt can be done anytime after cooling. However, once digested, the resulting solution must not be allowed to stand more than 48 hours to prevent precipitation of metal complexes. The analyst should examine each solution carefully to assure no precipitation has occurred.

6.4 Melts which are difficult to digest can be crushed with mortar and pestle to increase their surface area.

6.5 Samples containing magentite may be processed by an alternative procedure where magnetic Fe_2O_3 is to be included.

6.5.1 Samples are handled normally up to the digestion of the melt with nitric acid. At this point, the resulting solution is filtered to catch the undigested magnetite.

6.5.2 Place the wet filter paper containing the magnetite into a platinum crucible.

6.5.3 Preheat a muffle furnace to 750°C.

6.5.4 Ash the paper off in the furnace for 30 minutes.

6.5.5 Add 20ml of 50% HCl to the dish and digest on a hotplate.

6.5.6 Filter the solution into a 250ml volumetric flask. Use a Whatman #54 filter paper.

6.5.7 The results of the Fe_2O_3 analyses for both the ash and magnetite are composited to determine the total weight percent Fe_2O_3.

7.0 PREREQUISITES

7.1 The expiration date on all reagents must be checked and be acceptable before any samples are prepared.

7.2 Safety glasses and labcoats are required.

7.3 Fume hoods are required for all acid digestions.

7.4 Reagents must be prepared before samples are fused.

7.5 The analyst must be approved by the department supervisor and certified by the HCCL Training Program.

7.6 Reference HCL-180, "Utilization of a Mettler AC-100 Balance."

8.0 APPARATUS

8.1 Reference HCL-101, Section 8.0

8.2 Graphite crucibles, 9ml capacity, Spec Industries, Catalog #7152.

8.3 Platinum crucible, 35ml capacity.

8.4 Beaker, 400ml capacity, Pyrex brand, Class A.

8.5 Hotplate w/magnetic stirrer, Dyla-Dual, VWR Part No. 58849-001.

8.6 Volumetric flasks, 250ml capacity, Pyrex brand, Class A, T. C.

8.7 Volumetric flasks, 200ml capacity, Pyrex brand, Class A, T. C.

9.0 REAGENTS

9.1 All references to water will mean water with an electrical conductance of 0.8umho/cm or less. Type I deionized, conforming to ASTM specifications D1192.

9.2 Lithium Metaborate ($LiBO_2$).

9.3 Nitric Acid, concentrated, Sp. gr. 1.42.

9.4 Cesium Chloride, ACS reagent grade.

9.4.1 Cesium chloride solution, 2000ppm; Prepare by dissolving 25.3420gm CsCl in 200ml of deionized water. Transfer to 1000ml volumetric flask and dilute to the mark.

9.5 Tartaric Acid: ACS Reagent Grade.

9.5.1 Tartaric acid solution (125gms tartaric acid per 1 liter D.I. water).

9.6 Molybdivanadate Solution (used in P_2O_5 analysis).

Dissolve 0.6 grams of sodium metavanadate in 200ml of HNO_3 using a 400ml beaker and stir bar. Dissolve 38.0 grams of sodium molybdate in 200ml of water using a 1 liter volumetric flask. Mix the two solutions and dilute to the 1 liter mark.

9.7 P_2O_5 Standards

500 ppm stock solution - dissolve 1.0000 gram of disodium phosphate in the 200ml's of water. Transfer to a 1 liter volumetric and dilute to the mark.

5.0 ppm standard - using a 1 liter flask add 200ml of water, 4.000 ± .005gm $LiBO_2$, 10.000 ± .005gms tartaric acid and 50ml HNO_3. Then pipette 10ml of the 500ppm stock solution into the flask and bring to the mark with D.I. water.

9.8 TiO_2 Reagents

9.8.1 Lithium Tetraborate ($Li_2B_4O_7$), powder

9.8.2 Hydrochloric acid (5 + 95) - dilute 50ml of concentrated hydrochloric acid (HCl, sp. gr. 1.19) in a 1000ml volumetric flask using deionized water.

9.8.3 Titanium Standard Solution - fuse .1000gm ash of a Certified Standard containing approximately 1.50% TiO_2 with lithium tetraborate. Digest with 150ml of 5% HCl and quantitatively transfer to a 200ml volumetric flask.

10.0 <u>CALIBRATION</u>

10.1 Not applicable.

11.0 <u>TRAINING</u>

11.1 Conditions of Training.

11.1.1 The technician must be approved by the department supervisor to work with acids.

11.1.2 The technician must be certified in HCL-101.

11.1.3 The technician must be capable of preparing 16 samples for major elements in ash simultaneously.

11.1.4 The technician must be capable of recognizing samples contaminated with magnetite & samples contaminated by metal complex precipitation

11.1.5 The technician must be trained in the operation of the Leco SC-32, Varian AA-475, and Perkin-Elmer Lambda-3 UV-VIS spectrophotometer.

11.2 Standards of Training.

11.2.1 Results of the 16 samples prepared must meet the criteria listed in table one, section 14.0 of this procedure.

11.2.2 Results of the written exam must meet standards outlined in Administrative Procedure HCL-1013.

SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	RECOMMENDED PRACTICES
12.0 PROCEDURE		
12.1 Prepare the ash by ashing a sufficient quantity of coal to yield a minimum of 1.6000gms. of ash. Do not ash more than 1.0 gram of coal in one crucible. Mortar and pestle the ash to pass a 200 mesh screen. NOTE: If SO_3 is not required, the minimum weight requirement can be reduced to 1.000 grams.		Follow HCL-101 to prepare the ash. Determine the percent ash and calculate the number of grams of coal required to yield 1.600 grams of ash using equation: grams of coal $= \frac{(1.600\ \text{grams})}{\%\ \text{ash}}$ 100
12.2 Place a graphite crucible on the balance pan and tare it to zero.	Electronic or mechanical interference in the taring procedure.	Assure the readout displays 0.0000 grams.
12.3 Add approximately 0.5 ± 0.1 gms of $LiBO_2$.		
12.4 Create a depression in the Li BO_2 and then tare the weight.	Reference 12.2	Reference 12.2.
12.5 Accurately weigh 0.10 ± 0.0050 grams of ash into the crucible.		
12.6 Record the sample weight (ash weight) on the data sheet.		
12.7 Cover the mixture with approximately 0.5 grams of metaborate to assure an excess of fluxing agent.	Poor fusion of the ash.	Always make sure that enough metaborate was added to completely cover the ash. Do not allow the ash to touch the crucible.
12.8 Repeat steps 12.1 through 12.7 for all samples up to a total of 18.		Use a prelabled grid to keep the samples in correct order.
12.9 Repeat steps 12.1 through 12.7 for the duplicate and standard sample.		

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SAFE JOB PROCEDURE

SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	RECOMMENDED PRACTICES
12.10 Prepare a blank by addition of 1.0 gram of metaborate to a crucible.		
12.11 Preheat a muffle furnace to 900°C ± 20°C.		
12.12 Transfer the samples into the muffle and allow 40 minutes to form the melt.		
12.13 At the end of 40 minutes, remove the samples and allow them to cool.	Incomplete fusion to melt.	If the melt is not complete, return the samples to the furnace for an additional amount of time.
12.14 While the melts cool, prelabel the 400 ml beakers with sample numbers.		
12.15 Transfer the melts to the prelabeled beakers.		
12.16 Add 40 mls of H_2O and slowly add 12.5 mls of concentrated HNO_3.	Refer to Appendix E	Safety glasses and lab coats are required. Must be performed in a hood.
12.17 Add a stir bar to each beaker, being careful to avoid splashing.		
12.18 Set the hotplate on medium heat and place the beakers on it. (Just below boiling).		
12.19 Cover each beaker with a watch glass and begin stirring the solution slowly.		

SAFE JOB PROCEDURE

Procedure No. HCL-106 Revision Date: 7/19/85 Revision No. 3

SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	RECOMMENDED PRACTICES
12.20 Normally the melt should digest completely in twenty minutes or less. If this does not occur, increase the time until the melt is completely digested.	Precipitation of metal complexes.	Do not allow the solutions to boil.
12.21 Allow the solution to cool and check for residue (other than graphite) which was not digested. Filter the solution. If magnetite is present, handle the residue as outlined in section 6.5.	Failure to recognize magnetite will result in low Fe_2O_3 recovery.	Use Whatman #54 filter paper for speed. Magnetite will adhere very strongly to the stir bar.
12.22 Quantitatively transfer the solution to a clean, prelabeled volumetric flask (200 ml or 250 ml).	Sample loss during transfer.	
12.23 Add 20 mls of tartaric acid solution to each stock flask.		
12.24 Allow the samples to reach room temperature and then dilute to the mark with D. I. water. Stop the flasks.		Label this flask "STOCK" and the appropriate sample number.
12.25 From your stock solution, prepare analysis solution one.		
12.26 Prepare solution one by transfer of 50 ml of stock into a 100 ml volumetric flask prelabeled.		
12.26.1 Add 5.0 mls of HNO_3.		
12.26.2 Add 10.0 mls of 20,000 ug/ml Cesium solution.		
12.26.3 Dilute to volume using D.I. water.		

SAFE JOB PROCEDURE

SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	RECOMMENDED PRACTICES
12.27 Using the stock solution, determine °silicon (100-250 ug/ml) °iron (30-70 ug/ml) °potassium (0-20 ug/ml) °manganese (0-2 ug/ml) °magnesium (0.0-4.0 ug/ml)		
12.28 Using solution one, determine °calcium (0.0-5.0 ug/ml) °Sodium (0.0-5.0 ug/ml) °Aluminum (0.0-50.0 ug/ml)		
12.29 Operating conditions for each element is outlined in Table Two of Appendix B.		
12.30 Determine the percent sulfur in the ash using HCL-103.		
12.31 Determine the percent P_2O_5 using the UV-VIS spectrophotometer.		
12.32 Prepare the P_2O_5 standards using the directions in section 9.0 of this procedure.		
12.33 Transfer 50 ml's of the unknowns stock solution into a 100 ml beaker.		
12.34 Prepare a blank using the blank stock solution.		
12.35 Transfer 50 ml's of the 5.0 ppm P_2O_5 stnadard into a 100 ml beaker.		
12.36 Add 25 ml of the molybdivanadate to each beaker.		

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SAFE JOB PROCEDURE

SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	RECOMMENDED PRACTICES
12.37 Allow each sample to stand for 20 minutes.	Incomplete color development.	
12.38 Calibrate the UV-VIS using the 5.00ppm sample.		Reference the operating manual.
12.39 Determine the % P_2O_5 in each sample and record the results on the data sheet.		
12.40 TiO_2 Determination.		
12.41 Weigh 0.1000 ± .0002g of the ash into a clean platinum dish.	Contaminated crucibles.	Clean the crucibles by boiling in 5% HCl solution.
12.42 Add .5gm of lithium tetraborate ($Li_2B_4O_7$) and mix by rotating the dish.		
12.43 Add an additional .5gm of $Li_2B_4O_7$ to cover the mixture.		
12.44 Repeat steps 12.41 to 12.43 for each sample plus duplicate and QA standard.		
12.45 Prepare a blank by addition of 1.0gm of tetraborate to a crucible.		
12.46 Place the dish in a muffle preheated to 1000°C for 15 minutes.		Furnace temperature must be 1000 ± 20°C.
12.47 Remove after 15 minutes and cool to room temperature.		
12.48 Carefully rinse the bottom and outside of the platinum dish to remove possible contamination.		Contamination will cause erroneous results.

SAFE JOB PROCEDURE

SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	RECOMMENDED PRACTICES
12.49 Place the dish in a clean 400ml beaker.		
12.50 Place a clean stir bar inside the dish.		
12.51 Add 150ml of HCl solution (5 + 95) to the beaker & dish.		
12.52 Immediately place on a stirring hotplate & heat to just below boiling for no longer than 30 minutes.		If stirring is not maintained constantly, some of the ash constituents may precipitate. Do not allow the solution to boil.
12.53 After the melt has dissolved remove from the hotplate & cool to room temperature.		
12.54 Quantitatively transfer the solution to a 200ml volumetric flask and wash the beaker & dish with 5% HCl solution.		
12.55 Dilute to the mark with 5% HCl solution.		
12.56 Operating conditions are outlined in Table Two of Appendix B for the AA.		

13.0 CALCULATIONS

13.1 Weighted recomposite of Fe_2O_3 for magnetite contaminated samples.

D = (A) (B) + (C)

Where A = weight percent of magnetite in the ash.
B = weight percent of Fe_2O_3 in magnetite.
C = weight percent of Fe_2O_3 in ash.
D = weight percent of Fe_2O_3 total.

13.2 Reference Appendix A, Worksheet for Calculation of Metal Oxides from Element Concentrations in the Analysis Solutions.

14.0 ACCEPTANCE CRITERIA

Element	Percent of Moisture-Free Ash			
	Repeatability	Range	Reproducibility	Range
SiO_2	2	10 to 60	4	10 to 60
Al_2O_3	1	5 to 30	3	5 to 30
Fe_2O_3	1.0	5 to 50	2	5 to 50
CaO	1.0	2	1.0	2
CaO	0.25	2	0.5	2
MgO	0.20	0.3 to 10	0.6	2
MgO			0.2	2
Na_2O	0.5	5	0.7	5
Na_2O	0.1	5	0.2	5
K_2O	0.1	0.3 to 3	0.2	0.3 to 3
MnO_2	0.02	0.2	0.07	0.2
P_2O_5	0.2	0.3 to 3	0.4	0.3 to 3
TiO_2	0.2	0.5 to 2	0.4	0.5 to 2

14.2 Results of a test are rejected if the total percent recovery is less than 97% or greater than 102.5%. The sample is retested. If results of the retest do not meet the recovery requirements but do meet the requirements of repeatability when compared to run one, the average of the two runs is reported. If the retest does not meet the percent recovery or repeatability standards a third run is made. If the recovery of this run is outside the acceptable range, the average of all three runs is reported and a comment added to the report to reflect the results are the average of those runs.

APPENDIX A
Calculations Worksheet

METAL OXIDE	(Analysis Sample (ug/ml)) x	(Sample Volume (ml) / Sample Weight (gm) (Ash)) x	(Dilution Factor) x	(Gravimetric Factor) =	Result % Wt.
SiO_2				2.14×10^{-4}	
Al_2O_3				1.89×10^{-4}	
Fe_2O_3				1.43×10^{-4}	
K_2O				1.20×10^{-4}	
CaO				1.40×10^{-4}	
MgO				1.66×10^{-4}	
Na_2O				1.35×10^{-4}	
TiO_2				1.67×10^{-4}	
MnO_2				1.58×10^{-4}	
SO_3	NOT REQUIRED		NONE	2.497	
P_2O_5	DETERMINED DIRECTLY		----	-----	
PERCENT RECOVERY					

APPENDIX B
Operating Conditions for Elements

TABLE TWO

ELEMENT		WIDTH SLIT	CURRENT LAMP	WORKING RANGE LOW	HIGH	FLAME TYPE	BACK-GROUND	COMMENTS
Si	251.6	0.2	20	100	250	no	yes	Red cone 2-3cm Reducing yellow
Fe	372.0	0.2	5	10	100	NO	NO	Lean-Double Beam
Al	309.3	0.5	10	20	100	NO	NO	Red Cone 2-3cm Reducing Double Beam.
K	769.9	0.20	5	Optimize only		AA	NO	Flame Emission
Ca	422.7	0.2	10	Optimize only		NO	NO	Red Cone 1.0-1.5 cm reducing Flame emission
Mg	285.2	0.5	4	Optimize only		NO	Yes	Flame emission
Na	589.6	0.2	5	Optimize only		AA	NO	Flame Emission
Ti	364.3	0.2	20	5.0	20.0	NO	NO	Reducing 1.0-1.5 cm Red Cone, Double Beam
Mn	279.5	0.2	5	0.5	4.0	AA	NO	Oxidizing and Double Beam

APPENDIX C

Pennsylvania Electric Company
HOMER CITY LABORATORY
Ash Constituents

Sample Number	Lab Number	Sample Weight	ppm Si	dilution Si	ppm Al	dilution Al	ppm Fe	dilution Fe	ppm Ca	dilution Ca	ppm Mg	dilution Mg

Sample Number	Lab Number	% SO_3	ppm Na	dilution Na	ppm K	dilution K	ppm Ti	dilution Ti	ppm Mn	dilution Mn	ppm P_2O_5	dilution P_2O_5

APPENDIX D

More About Chemicals We Use:

Nitric Acid: (HNO_3)

Nitric Acid is a clear to light brown liquid. It causes severe skin and eye burns and its vapors can cause damage to the lungs. It is very corrosive and will attack most metals. When it is allowed to contact wood it may cause a fire. It may also ignite paper, cotton and burlap. When you are working with HNO_3, always do so in an operating hood.

Nitric Acid will produce severe and penetrating burns to the skin and membranes. Contact with the eyes will produce very severe, immediate damage and may result in permanent damage.

Nitric Acid should be stored to safeguard against mechanical injury of containers; isolate from turpentine, combustible materials, carbides, metallic powders, fulmites, picrates or chlorates. Do not store with Acetic Acid or Hydrochloric Acid.

Penelec / GPU	HOMER CITY LABORATORY
TITLE: SUSPENDED SOLIDS	
PROCEDURE NO: HCL-204	REVISION DATE: 9/21/84
COPY NO:	REVISION NO: 1
PAGE 1 OF 19	EFFECTIVE DATE: DEC 19 1984

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4	9/21/84	1	14	9/21/84	1			
5	9/21/84	1	15	9/21/84	1			
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7	9/21/84	1	17	9/21/84	1			
8	9/21/84	1	18	9/21/84	1			
9	9/21/84	1	19	9/21/84	1			
10	9/21/84							

ORIGINATOR: Raymond C [illegible]	DATE: 12/19/84
APPROVAL: Thomas [illegible]	DATE: 12/19/84
AUTHORIZATION FOR LAB USE: [illegible]	DATE: 12 19 84

REAPPROVED:	DATE:

CANCELED:	DATE:

1.0 REFERENCES

1.1 Existing acceptable industry methods.

1.2 Method HCL-1001, "Preparation of Technical Procedures."

1.3 Method HCL-1003, "Data Acquisition System Operation and Training Manual."

1.4 Method HCL-201, "Gross Air Dry Loss."

1.5 Method HCL-237, "Mettler PK-36 Balance."

1.6 Method HCL-238, "Operation of the Toledo Scale."

2.0 SCOPE AND APPLICATION

2.1 This method is applicable to all slurries received at Homer City Coal Laboratory independent of coal type.

2.2 Samples received with a surface moisture of less than twenty percent should be processed by Method HCL-201, "Gross Air Dry Loss."

2.3 Sensitivity of this test is equal to the sensitivity of the weighing device used.

2.4 Results of this test represent the solids content in the original volume of slurry received.

3.0 SUMMARY OF METHOD

3.1 A coal slurry sample is dewatered and dried for 48 hours maximum either at 10°C to 15°C above ambient (not to exceed 40°C) or atmospherically (avoiding excess dust and air current interference) to a workable dryness.

3.2 The remaining dry weight relative to initial wet weight yields the suspended solids (see 13.2).

4.0 DEFINITIONS

4.1 None.

5.0 INTERFERENCES

5.1 Atmospheric conditions may greatly affect this analysis. Containers of sample must be tightly sealed up to the time of dewatering and the dry coal not exposed to the air for extended periods.

6.0 SAMPLE HANDLING AND PRESERVATION

6.1 Samples must be collected in a container that is larger than or has the volume of one gallon to produce viable results.

6.2 The sample may consist of one or more containers.

6.3 All samples must be weighed upon receipt and this weight recorded as the "gross weight" of the sample.

6.4 The technician must check this "gross weight" when beginning the "suspended solids" test. If a discrepancy exists between the starting gross weight and the original gross weight notify the shift supervisor. Moisture losses or gains prior to processing must be investigated and included in total air dry loss.

7.0 PREREQUISITES

7.1 Calibration of scale(s) or balance (refer to Section 10).

7.2 Calibration of oven (refer to Section 10).

7.3 Prior to beginning the test always check the process form for special handling notes.

8.0 APPARATUS

8.1 Mettler PK-36 balance with a maximum capacity of 30,000 grams and the readability of 0.1 grams, when the mass is less than 6000 grams; and 1.0 grams when the mass is greater than or equal to 6000 grams.

8.2 Scales

8.2.1 Toledo Model 2184 scale with Model 8130 digital readout having a 300 kilogram capacity and a readability of 0.1 kilograms.

8.2.2 Toledo Model 4181-001 mechanical scale with the capacity of 1000 pounds and a readability of 0.5 pounds.

8.3 Drying Trays

8.3.1 Galvanized steel trays of the dimension 34" x 48" x 3" with handles, located at Homer City Coal Laboratory.

8.3.2 Galvanized steel trays of the dimension 36 1/2" x 42 1/2" x 2 3/4" without handles, for use at EPRI-CCTF facility.

8.3.3 Fiberglass trays of the dimension 36 1/2" x 42 1/2" x 2 3/4" without handles for use at EPRI-CCTF facility.

8.4 Blue "M" Air Drying Ovens, Model No. POM-966A-R16X located at the EPRI-CCTF facility maintained at 40°C ± 5°C.

8.5 Soil Test Oven, Model L-72A maintained at 40°C ± 5°C.

8.6 Air drying racks large enough to accomodate drying trays as described in section 8.3.1. These racks are used for the atmospheric drying.

8.7 Filtering Device

8.7.1 Denver Filter which uses 32 cm ashless filter paper, hooked in series with two side arm Erlenmeyer flasks, and a vacuum pump. The side arm Erlenmeyer flasks are used for filtrate collection and filtrate clarity monitoring.

8.7.2 Vacuum Filtration system at the EPRI-CCTF facility.

8.7.2.1 Raven vacuum filtering vats, 25" in diameter.

8.7.2.2 Eimco filter bags which are contoured to fit the Raven vacuum filtering vats.

8.7.2.3 Nash vacuum pump, Model 202, operating at 2000 RPM.

8.7.2.4 Filtrate collection tank, Cemline 34104, with a diameter of 36" and length of 92".

9.0 <u>REAGENTS</u>

9.1 Not applicable.

10.0 CALIBRATION

10.1 Toledo Model 4181-001 mechanical scale.

10.1.1 Set scale at zero, by removing all counterweights and moving the sliding weight down the bar until the arrow on the weight points directly at the zero mark on the bar.

10.1.2 Place the 500 lb. equivalent on the counter weight holder. Gently set the 500 lb. calibration weight on the scale's platform and observe the reading.

10.1.3 If the scale reads 500 lbs. ± .5 lbs. then the scale is properly calibrated. If the scale reads outside of the limits, proceed with steps 10.1.4 and 10.1.5.

10.1.4 Remove the calibration weight and the counter weight. Check the level of the scale's platform. Check under the scale's platform for dirt and clean if necessary. Finally, with the scale set at zero, check to see if the arm for the slide weight moves freely.

10.1.5 After checking all the items in 10.1.4, repeat steps 10.1.1 thru 10.1.3. If the scale still does not meet the calibration criteria, as stated in 10.1.3, contact the shift supervisor and do not use the scale.

10.1.6 Calibration must be accomplished once per shift.

10.2 Blue M Model No. POM-966A-R16X air dry loss oven.

10.2.1 Once each operating shift empty and preheat the oven.

10.2.2 After the oven has reached its operating temperature, place a certified thermometer in the center of the oven.

10.2.3 Allow sufficient time for the thermometer to equilibrate to the oven's temperature, quickly remove and read. Record all temperature checks in the "Blue M Drying Oven Calibration Log" with date, time and technician initials.

10.2.4 If the temperature is not within 35°C ± 5°C, suspend oven usage and contact your shift supervisor.

10.2.5 The shift supervisor will adjust oven controls, supervise oven recalibration and assure calibration log is properly annotated prior to analysis resumption.

11.0 TRAINING

11.1 Condition

11.1.1 The technician will perform five analyses on samples with varying solids content.

11.2 Standard

11.2.1 The technician will perform the percent suspended solids, within the average units-per-hour figures and acceptance criteria limits of section 14.1.

SAFE JOB PROCEDURE

Procedure No. HCL-204 Revision Date: 9/21/84 Revision No. 1

SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	RECOMMENDED PRACTICES
12.0 PROCEDURE		
12.1 Locate the sample to be analyzed, the corresponding process form and data sheet.	Missing or incorrect sample container.	Always check the sample's container(s) and nomenclature with the process form's description and container ID section. If a discrepancy is noticed, always contact shift supervisor.
12.2 Weigh the container(s) and record the container(s) ID and initial slurry weight on the data sheet (Appendix I). Enter data directly into the computer, when available. (When entering the container ID and initial slurry weight in the computer, the filter paper weight must also be entered for each container.)	Incorrect weights.	The balance or scale must be regularly calibrated and zeroed before weighing samples. All containers must be weighed without lids. Any container with the initial slurry weight less than 16 kilograms must be weighed on the Mettler PK-36 balance. All samples weighed at EPRI will be weighed in pounds. The pound weights of the containers will be recorded on the back of the data sheet, and the gram equivalent recorded in the appropriate areas on the front of the data sheet.
	Personal injury.	Steel toed footwear is required at both HCL and the EPRI facility. Always use proper drum handling equipment when moving drums. Wear cotton work gloves when moving drum to avoid possible injury to hands and fingers.
12.3 Dewater the sample.	Loss of sample.	Samples need to be placed entirely in the filtering device. The container must be thoroughly rinsed. Insure that while washing out the container all the residue flows into the filtering device.

Penelec / GPU

Pennsylvania ctric Company
HOMER CITY LABORATORY

SAFE JOB PROCEDURE

Procedure No. HCL-204 Revision Date: 9/21/84 Revision No. 1

SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	RECOMMENDED PRACTICES
12.3.1 Dewatering at Homer City Coal Laboratory.		
12.3.1.1 Set up Denver filtering aparatus (Appendix II).	Contamination of sample.	Brush any residue from the Denver filter and lightly blow dust off with air hose.
	Chemical residue.	Never take a Denver from the F/S room until it has been dried in a F/S oven for several hours.
	Personal injury.	The Denver filtering device and the side arm Erlenmeyer flasks should be placed on a level, flat surface that will be easily accessible to the technician. The Erlenmeyer must be supported to prevent tipping.
12.3.1.2 Place the preweighed 32 cm ashless filter paper in the Denver filtering device. (Record the weight of the filter paper on the back of the data sheet.)	Loss of sample through filter.	Check each filter paper for holes or tears that would allow solids to pass through during the dewatering operation. While dewatering the sample always check the clarity of the filtrate. If the filtrate should suddenly become cloudy, or residue is noticed forming in the flask, remove the present filter paper and refilter the filtrate using a new one.
12.3.1.3 Decant liquid off of sample.	Sample spillage.	If the container is too full to permit pouring use a clean flask and ladle the liquid out of the container. Never allow the slurry to splash over the sides of the filtering device.
	Slow filtration.	Leave the solids settle in the container so that the slurry being decanted is relatively free of solids.

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SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	RECOMMENDED PRACTICES
12.3.1.4 Pour sediment onto paper and rinse container thoroughly.	Loss of sample.	See 12.3.
12.3.1.5 Repeat steps 12.3.1.2 through 12.3.1.4 for all containers until the sample has been completely dewatered, changing the filter papers when necessary.		
12.3.1.6 Clean and weigh enough pans to hold all the filter papers and filtered solids. Record the pan ID's and weights on the data sheet. Enter pan and filter paper weights into the computer.		
12.3.1.7 Position filter papers and filtered solids onto pans and place into soil test oven, drying according to Method HCL-201, "Gross Air Dry Loss."	Sample identification.	Place a card identifying the sample and lab number in the pan with the sample.
12.3.1.8 When drying is complete weigh and record on data sheet (Appendix I). Enter weight into the computer.		
12.3.1.9 Seal the sample in an air tight container to await further analysis.		
12.3.2 Dewatering at the EPRI-CCTF facility.		

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SAFE JOB PROCEDURE

Procedure No. HCL-204 Revision Date: 9/21/84 Revision No. 1

SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	RECOMMENDED PRACTICES
12.3.2.1 When CCTF personnel are on site, check with the proper authorities before operating any equipment.	Interference with plant operations.	Never operate any equipment without first receiving clearance.
12.3.2.2 Drain Receiving Tank	Strain on vacuum pump due to full receiving tank.	This procedure must be performed at the beginning of every shift and with every four hours of operation.
12.3.2.2.1 Pull valve #1 near receiving tank to the open position. Push drain valve (#2) handle (large pipe handle near floor) to open drain.	Turning wrong valves.	A sketch of the valve system is shown in Appendix III. The valves in question are labeled at EPRI to correspond with the sketch. A copy of the sketch is posted in the vacuum pump/receiving tank room at the EPRI facility.
12.3.2.2.2 Restore valves to original position after all the water has been drained from the tank.		
12.3.2.3 Check the water pressure to the vacuum pump.	Equipment damage.	This must always be performed before operating the vacuum pump.
12.3.2.3.1 Open valve #3 and observe the rate the water is discharged from the pipe. If the water flows steadily from the pipe water pressure is sufficient. Reclose the valve. If the water pressure does not flow steadily water pressure is insufficient to operate the pump.	Turning wrong valve. Equipment failure.	Refer to Appendix IV. Contact shift supervisor.
12.3.2.4 Vacuum pump startup.		

SAFE JOB PROCEDURE

Procedure No. HCL-204 Revision Date: 9/21/84 Revision No. 1 Page 11 of 19

SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	RECOMMENDED PRACTICES
12.3.2.4.1 Open valve (#4) located below strainer to purge the pump with water.	Turning wrong valve. Equipment damage.	Refer to Appendix IV. This valve must remain open while the pump is activated. The water must always flow through the pump; if the water flow ceases, shutoff the pump and contact shift supervisor.
12.3.2.4.2 Locate stop/start switch (#5) and push black button, marked ON. Immediately a red light, directly above the switch, will light up indicating that the pump is engaged (Appendix IV).		
12.3.2.5 Dewater the sample.	Insufficient vacuum.	Do not begin dewatering until the vacuum has reached 20 inches. A gauge is located on the wall to the left of the five dewatering devices. The vacuum should reach this level after the pump has been activated for 2 minutes (Appendix V).
12.3.2.5.1 Place filter bag in filtering device.	Contamination. Loss of sample.	Always clean every filter bag thoroughly before using. Check the bag for holes or tears (particularly around seams). Leave more than 1 inch of bag hanging over the outside of the device to keep the bag from falling inside during the dewatering process.
12.3.2.5.2 After placing the bag in the dewatering device, spray it with a hose and turn on the vacuum.		

SAFE JOB PROCEDURE

Procedure No. HCL-204 Revision Date: 9/21/84 Revision No. 1

SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	PECOMMENDED PRACTICES
12.3.2.5.3 Decant the liquid off the solids. Label each filtering device with sample number being dewatered.	Loss of sample. Personal injury.	If the container is too full to pour the liquid off the residual solids, then use a clean beaker or bucket to ladle the liquid. Always use proper drum handling equipment.
12.3.2.5.3.1 Drums of sample that have slurry between liner and the drum.		
12.3.2.5.3.1.1 Use a retaining ring and securely fasten an 8 mesh Kason screen on the top of the drum. Leave the liners sealed.		
12.3.2.5.3.1.2 Decant liquid from around the liner into a filtering device.	Spillage.	Extreme care has to be demonstrated in decanting directly from the barrel into the filtering device.
12.3.2.5.3.1.3 After decanting the liquid from around the liner, remove the Kason screen and open liner. Proceed with dewatering the slurry.		
12.3.2.5.4 Using a hose, flush solids into the filtering vat from the liner insuring all material has been removed.	Sample loss.	Care must be taken to eliminate splashing out over the vat's side.
12.3.2.5.5 Dry the container, weigh and record weight on the data sheet.		
12.3.2.6 Repeat sections 12.3.2.5 through 12.3.2.5.3.1.3 for all containers until the sample is completely dewatered.		

SAFE JOB PROCEDURE

SEQUENCE OF JOB STEPS	POTENTIAL PROBLEMS OR HAZARDS	RECOMMENDED PRACTICES
12.4 Transfer the sample and filter(s) onto drying trays. Dry the sample as per Method HCL-201, "Gross Air Dry Loss".	Incorrect dry weights.	Samples that have had their filter(s) weight recorded need the filter(s) included in the dry coal and container weights.
12.5 Return dry material to the original containers and weigh. Record weight on data sheet.		
12.6 Seal sample in an airtight container to await further analyses.		
12.7 Enter data into computer system.		

13.0 CALCULATIONS

13.1 Calculate the percent suspended solids of a gross sample as follows:

$$A = \frac{(R - F) - WC}{WT - WC} \times 100$$

Where A = % suspended solids

R = weight of residue, container and filter(s)

F = weight of filter(s)

WT = weight of container and initial slurry

WC = weight of dry container

13.2 The computer program for calculating percent suspended solids of a gross sample is in the PAMCON subsystem, and can be accessed by requesting program 204 (reference Method HCL-1003, section 4.5, page IV-18).

14.0 ACCEPTANCE CRITERIA

14.1 The percent suspended solids cannot be greater than 99.9% or less than 0.1%.

APPENDIX I

PENNSYLVANIA ELECTRIC COMPANY
HOMER CITY LABORATORY
% SUSPENDED SOLIDS

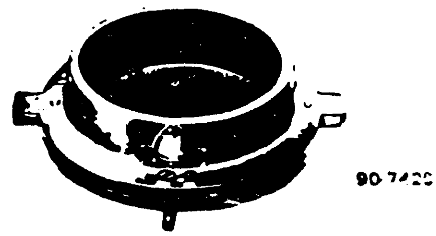
LINE NO.	SAMPLE NUMBER	LAB NO.	CONTAINER ID.	WEIGHT OF CONTAINER+ CONTENTS(WT)	WEIGHT OF CONTAINER (WC)	WEIGHT OF RESIDUE FILTER PAPER, &CONTAINER(B)	WEIGHT OF FILTER PAPER (F)	VALUE
	A	B	C	D	E	E	G	
1	340300355	4	0563 1072	18425.0	939.4	15616.0	6.2	74.70
2			0674 2012	22827.0	987.5	15698.0	6.5	
3								
4								
5								
6								
7								
8								
9								
10								

OPERATOR NO: ____________ ANALYST: ____________ DATE: ________

Entered

APPENDIX II

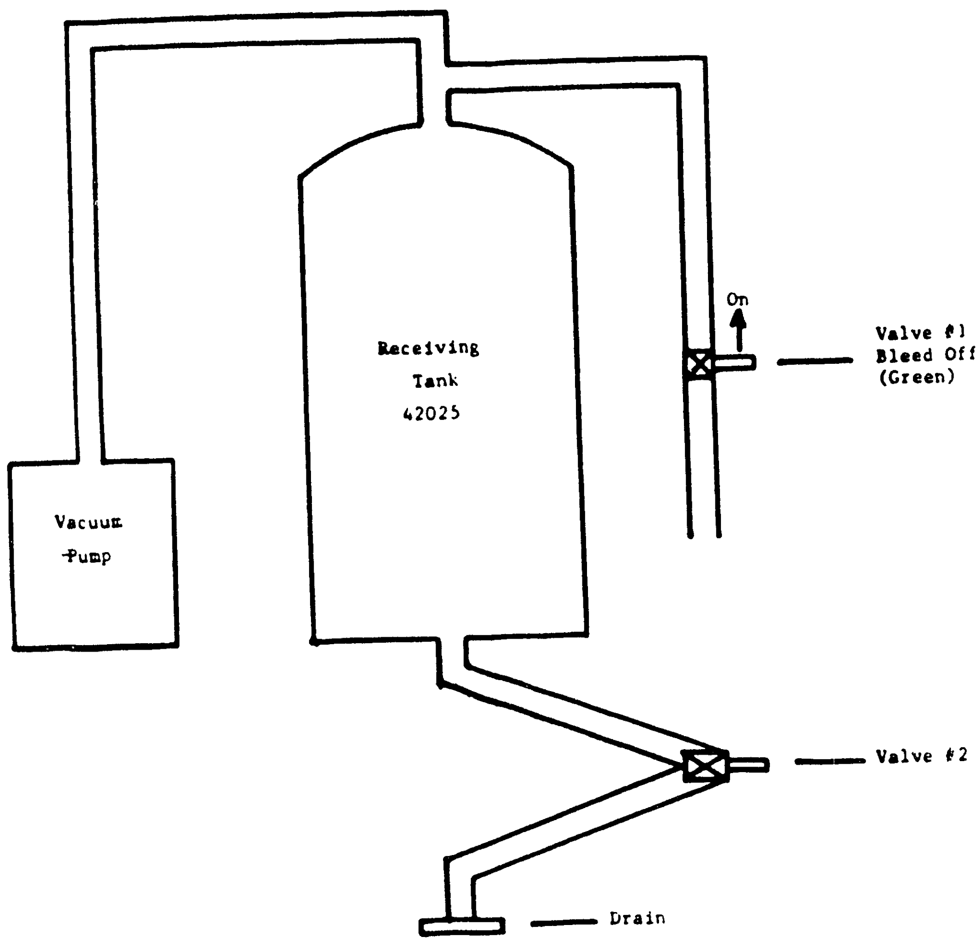
Denver Filtering Apparatus



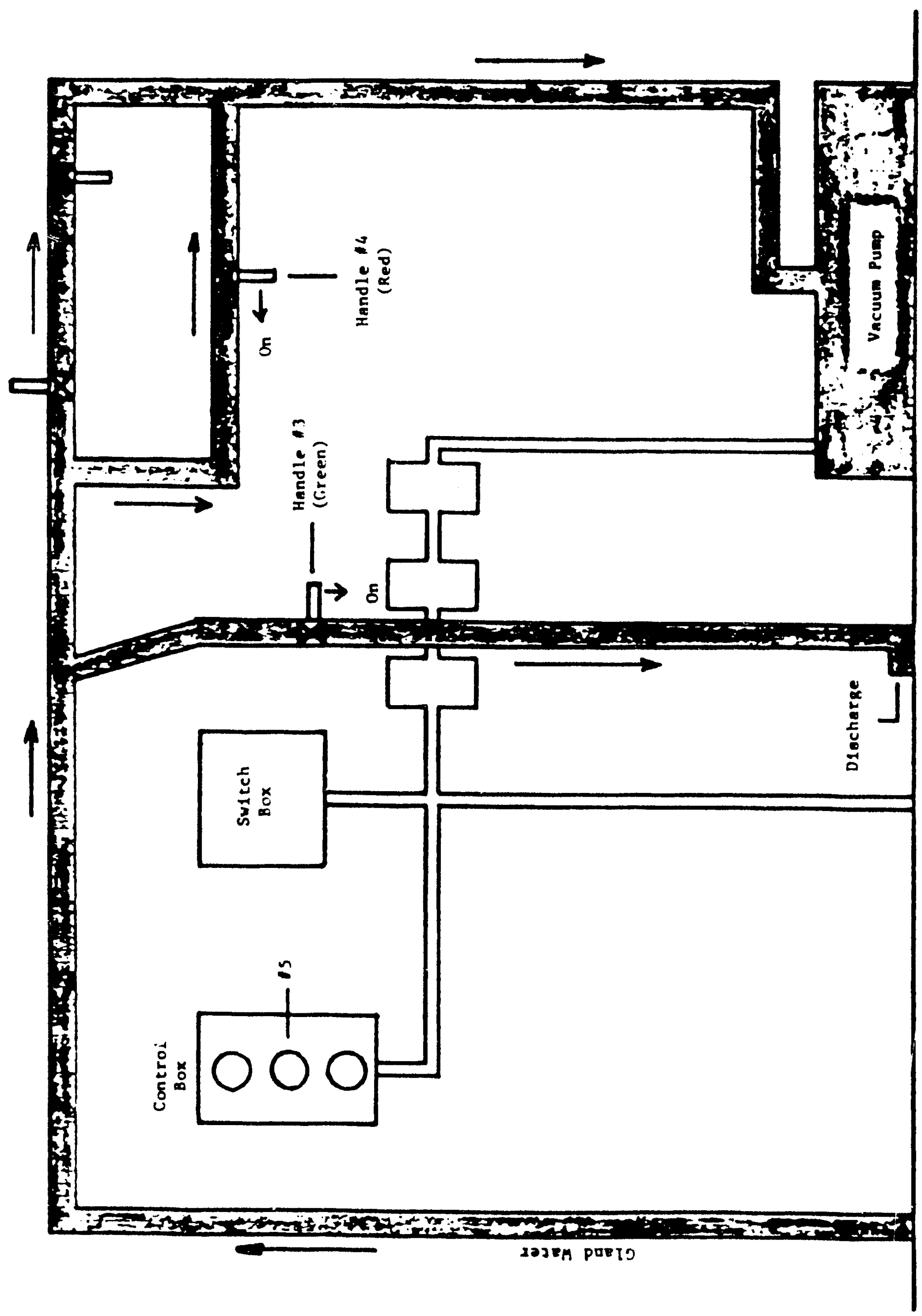
90-7420 FILTER—Laboratory, Vacuum, Denver

Heavy-Duty Sidearm Flasks

APPENDIX III



APPENDIX IV



Handle #4
(Red)
On
Vacuum Pump
Handle #3
(Green)
On
Discharge
Switch
Box
#5
Control
Box
Gland Water

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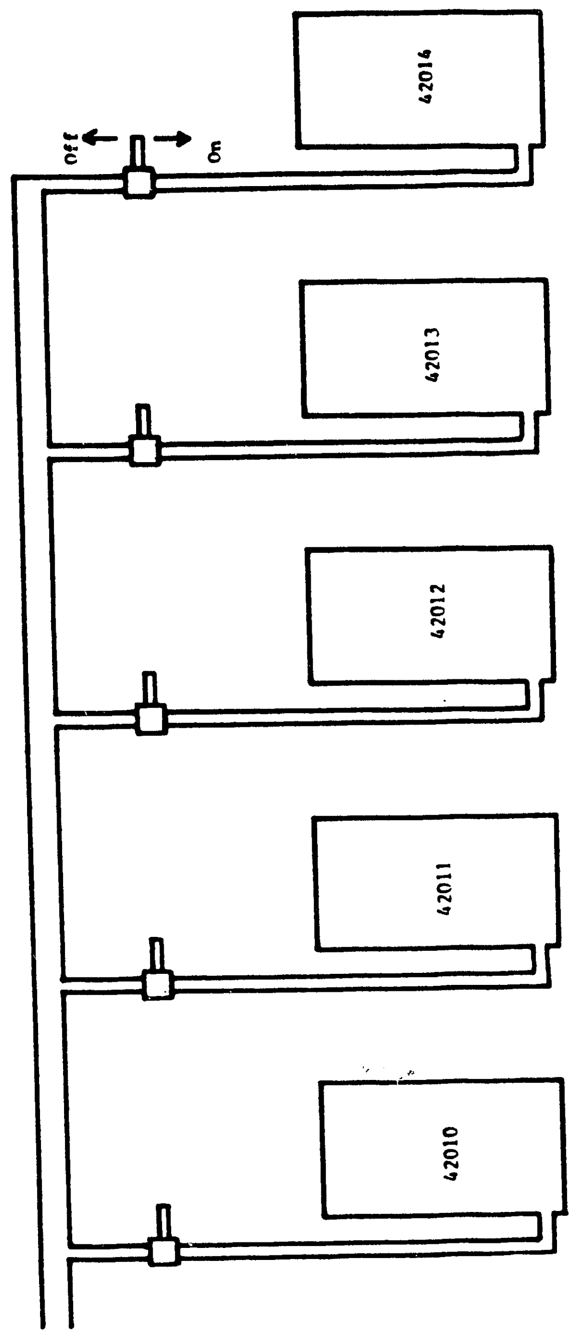
APPENDIX V

SAMPLE DEWATERING DEVICES

IMPORTANT: The vacuum gauge is located on the wall to the left of the dewatering devices, above the soda vending machine.



APPENDIX I

ANALYZER SYSTEM SOFTWARE LISTING

```
/**********************************************************************
/*
/*      CalSA.C
/*      DOE S & ASH ANALYZER, B&W RDD 4554
/**********************************************************************

#include        < StdIo.H >
#include        < Graph.H >
#include        < Colors.H >
#include        < ConIo.H >
#include        < Keys.H >
#include        < String.H >
#include        < CType.H >
#include        < Time.H >
#include        < Math.H >

int             Calc_H4_Slope_Offset( float _v_hi, float _v_lo );

#include        "Sa.H"
#include        "Proto.H"

#define         N_M2_STRINGS 6

_BOX m2 =       { N_M2_STRINGS,
                        {       "      Peristaltic Pump P4        ",
                                "        Metering Pump P3         ",
                                "         Opacity Meter           ",
                                "      Opacity Meter (Auto)       ",
                                "         Pressure Sensor         ",
                                "        Return to Main Menu      "  },

                        _Black, _White,

                        {       "Calibration Subroutines:" },
                        _Light_Cyan, -1,

                        0, 12, (80-(58-26))/2, 0
                };

#define _FILL_TUBES_P4          30.0
#define _FILL_BEAKER_P4         ( 1.0 * 60.0 )

#define _FILL_TUBES_P3          30.0
#define _FILL_BEAKER_P3         ( 1.0 * 60.0 )

int     Calibrate()
{

        _CALMENU:

        SBC(_Blue); STC(_White); CLS; Start_Up_Message();

        switch( PrintBox(&m2) ){

          case 0:       Calibrate_P4();
```

```
                    goto _CALMENU;

        case 1:     Calibrate_P3();
                    goto _CALMENU;

        case 2:     Calibrate_Opacity_Probe();
                    goto _CALMENU;

        case 3:     AutoOpacCal();
                    goto _CALMENU;

        case 4:     /* Calibrate_Pressure_Sensor(); */
                    Cal_PS();
                    goto _CALMENU;

        case 5:     break;

        default:    goto _CALMENU;

        }

      SBC(_Blue);
      CLS;
      return(-1);


}

int   Calibrate_P4()
{

      int     _i, _r, _c;
      float   _old_rp4_max;
      char    _buff[128];

      _BOX p4box = {  3,
                      {       "   Calibrate pump at 5 volts    ",
                              "  Set value of flow at 5 volts  ",
                              "             Exit               " },
                              _Black, _White,
                              { "" },
                              -1, -1,
                              0, 1, (80-(67-34))/2, 0
                      };

      static char *_s0[4] = {

      "       Set or Calibrate Peristaltic Pump (P4)",

      "Since 0 Volts is zero flow and 5 volts is maximum flow, It",
      "is only necessary to set (or calibrate) the point at 5 volts.",

      "Do you want to:"              };

      /* ------------------------------------------- */
```

```
/*      Display calibrate P4 options                         */
/* -------------------------------------------------------- */

_DISPP4OPTIONS:

SBC(_Blue); CLS;

_r=2, _c=10;

STC(_Bright_White);
LOC(_r,_c); _outtext(_s0[0]);

STC(_Light_Green);
LOC(_r+2,_c); _outtext(_s0[1]);
LOC(_r+3,_c); _outtext(_s0[2]);
LOC(_r+5,_c); _outtext(_s0[3]);

p4box.row = _r+7;
p4box.col = _c;

/* ---------------------------- */
/*      Switch option           */
/* ---------------------------- */

_CALP4:

switch( PrintBox(&p4box) ){

  case 0:        _old_rp4_max = rp4_max;
                 Set_P4_Max();
                 sprintf( _buff, "RP4_MAX changed from %.3f to %.
                 _old_rp4_max, rp4_max );
                 LogSA( _buff );
                 Write_P4_File();
                 goto _DISPP4OPTIONS;;

  case 1:        _old_rp4_max = rp4_max;
                 _r = p4box.row + p4box.nstrings + 4;
                 STC(_Bright_White); SBC(_Blue);
                 LOC(_r,_c); _outtext("Input the value of the flo
                 LOC(_r+1,_c); _outtext("rate at 5 volts:");

                 LOC(_r+3,_c); STC(_Black); SBC(_Light_Cyan);

                 while(-1){

                   switch(GetFloat(&rp4_max,10,_NEW)){

                     case 0:     sprintf( _buff,
                                 "RP4_MAX changed from %.3f to %.
                                 _old_rp4_max, rp4_max );
                                 LogSA( _buff );
                                 Write_P4_File();
                                 goto _CALP4;
```

```
                                case ESC:   goto _CALP4;

                                 }
                               }

          case 2:          break;

          default:         goto _CALP4;

          }

        return(-1);
}

int     Set_P4_Max()
{

        int                 _r, _c, _i, _seconds, _minutes;
        time_t              _init_t, _end_t, _current_t;
        char                _buff[128];
        static char         *_s0[4] = {

        "                   Calibrate Peristaltic Pump",

        "Prepare either a graduated cylinder or a \"tared\" beaker on a
        "Hit \x11\xc4\xd9 once and direct the pump outlet to a drain.",
        "The pump will be activated for 30 seconds to fill the tubes."

        };

        static char *_s1[2] = {

        "Direct the outlet of the pump to the graduated cylinder or beak
        "Hit \x11\xc4\xd9 once and allow cylinder or beaker to fill for
        };

        /* ------------------------------------------- */
        /*      Display calibration instructions       */
        /* ------------------------------------------- */

        SBC(_Blue); CLS;        _r=2, _c=2;

        STC(_Bright_White);
        LOC(_r,_c); _outtext( _s0[0] );

        STC(_Light_Green);
        LOC(_r+=2,_c); _outtext( _s0[1] );
        LOC(++_r,_c);  _outtext( _s0[2] );
        LOC(++_r,_c);  _outtext( _s0[3] );
        LOC(_r+=2,_c);

        /* ---------------------------- */
        /*      Wait for CR             */
        /* ---------------------------- */
```

```
do
   _i=gc();
while
   (_i!=CR);

/* ------------------------------------ */
/*      Fill tubes for 60 seconds       */
/* ------------------------------------ */

time( &_init_t );
_init_t += 4;
_end_t = _init_t + (time_t)_FILL_TUBES_P4;

_displaycursor(_GCURSOROFF);
STC(_Light_Cyan);

do{
   time( &_current_t );
   LOC(_r,_c);
   _outtext( (_current_t & 1) ? "*" : " " );
   }

while
   ( _current_t != _init_t );

SetP4( rp4_max );

do{
   LOC(_r,_c);
   sprintf( _buff, " 0:%02ld", _end_t-time( &_current_t ) );
   _outtext(_buff);
   }

while
   ( _end_t != _current_t );

SetP4( 0.0 );

_displaycursor(_GCURSORON);

/* ---------------------------------------------------------- */
/*      Display instructions for filling the beaker           */
/* ---------------------------------------------------------- */

_r+=2;

STC(_Light_Green);
LOC(_r,_c); _outtext( _s1[0] );
LOC(++_r,_c); _outtext( _s1[1] );

/* ---------------------------- */
/*      Wait for CR             */
/* ---------------------------- */

do
```

```
  _i=gc();
while
  (_i!=CR);

/* ------------------------------------------ */
/*      Wait 4 seconds before starting        */
/* ------------------------------------------ */

_r+=2;  STC(_Light_Cyan);

time( &_init_t );
_init_t += 4;

_end_t = _init_t + (time_t)_FILL_BEAKER_P4;

_displaycursor(_GCURSOROFF);

do{
  time( &_current_t );
  LOC(_r,_c);
  _outtext( (_current_t & 1) ? "*" : " " );
  }
while
  ( _init_t != _current_t );

/* -------------------- */
/*      Start           */
/* -------------------- */

SetP4( rp4_max );

do{
  _seconds = _end_t - time( &_current_t );
  _minutes = _seconds / 60;
  _seconds -= _minutes * 60;
  LOC(_r,_c);
  sprintf( _buff, "%2d:%02d", _minutes, _seconds );
  _outtext(_buff);
  }

while
  ( _current_t != _end_t );

SetP4( 0.0 );

_displaycursor(_GCURSORON);

/* ------------------------------------------ */
/*      Ask how much fluid was pumped         */
/* ------------------------------------------ */

_r+=2;

STC(_Light_Green);
LOC(_r++,_c);
```

```
_outtext( "How much fluid was pumped (ml) ?:" );

_VP4:
LOC(_r,_c); STC(_Black); SBC(_Light_Cyan);
switch( GetFloat( &p4_vol, 10, _NEW ) ){
  case 0:        break;
  case ESC:      break;
  default:       goto _VP4;
  }

/* ---------------------------- */
/*      Calculate rp4_max       */
/* ---------------------------- */

rp4_max = ( p4_vol * 60.0 ) / _FILL_BEAKER_P4;

SBC(_Blue);

LOC(_r+=2,_c); STC(_Bright_White); _outtext("RP4_MAX changed to:
sprintf( _buff, "%.3f", rp4_max );
STC(_Light_Cyan); _outtext(_buff);

while(kbhit());
gc();
return(-1);



}

int     Calibrate_P3()
{

    int     _i, _r, _c;
    float   _old_rp3_max;
    char    _buff[128];

    _BOX p3box = {  3,
                    {       "    Calibrate pump at 20 mA    ",
                            "   Set value of flow at 20 mA  ".
                            "            Exit               " },
                            _Black, _White,
                            { "" },
                            -1, -1,
                            0, 1, (80-(76-34))/2, 0
                    };

    static char *_s0[4] = {

    "       Set or Calibrate Metering Pump (P3)",

    "Since 4 mA is zero flow and 20 mA is maximum flow, It is",
    "only necessary to set (or calibrate) the point at 20 mA.",

    "Do you want to:"               };
```

```
/* ------------------------------------------- */
/*      Display calibrate P3 options           */
/* ------------------------------------------- */

_DISPP3OPTIONS:

SBC(_Blue); CLS;

_r=2, _c=10;

STC(_Bright_White);
LOC(_r,_c); _outtext(_s0[0]);

STC(_Light_Green);
LOC(_r+2,_c); _outtext(_s0[1]);
LOC(_r+3,_c); _outtext(_s0[2]);
LOC(_r+5,_c); _outtext(_s0[3]);

p3box.row = _r+7;
p3box.col = _c;

/* ---------------------------- */
/*      Switch option           */
/* ---------------------------- */

_CALP3:

switch( PrintBox(&p3box) ){

  case 0:       _old_rp3_max = rp3_max;
                Set_P3_Max();
                sprintf( _buff, "RP3_MAX changed from %.3f to %.
                _old_rp3_max, rp3_max );
                LogSA( _buff );
                Write_P3_File();
                goto _DISPP3OPTIONS;;

  case 1:       _old_rp3_max = rp3_max;
                _r = p3box.row + p3box.nstrings + 4;
                STC(_Bright_White); SBC(_Blue);
                LOC(_r,_c); _outtext("Input the value of the flo
                LOC(_r+1,_c); _outtext("rate at 20 mA:");

                LOC(_r+3,_c); STC(_Black); SBC(_Light_Cyan);

                while(-1){

                  switch(GetFloat(&rp3_max,10,_NEW)){

                    case 0:     sprintf( _buff,
                                "RP3_MAX changed from %.3f to %.
                                _old_rp3_max, rp3_max );
                                LogSA( _buff );
                                Write_P3_File();
```

```
                                        goto _CALP3;

                            case ESC:   goto _CALP3;

                            }
                          }

          case 2:       break;

          default:      goto _CALP3;

          }

        return(-1);
}

int     Set_P3_Max()
{

        int             _r, _c, _i, _seconds, _minutes;
        time_t          _init_t, _end_t, _current_t;
        char            _buff[128];
        static char     *_s0[4] = {

        "               Calibrate Metering Pump",

        "Prepare either a graduated cylinder or a \"tared\" beaker on a
        "Hit \x11\xc4\xd9 once and direct the pump outlet to a drain.",
        "The pump will be activated for 30 seconds to fill the tubes."

        };

        static char *_s1[2] = {

        "Direct the outlet of the pump to the graduated cylinder or beak
        "Hit \x11\xc4\xd9 once and then what ???"
        };

        /* -------------------------------------------- */
        /*      Display calibration instructions        */
        /* -------------------------------------------- */

        SBC(_Blue); CLS;        _r=2, _c=2;

        STC(_Bright_White);
        LOC(_r,_c); _outtext( _s0[0] );

        STC(_Light_Green);
        LOC(_r+=2,_c); _outtext( _s0[1] );
        LOC(++_r,_c);  _outtext( _s0[2] );
        LOC(++_r,_c);  _outtext( _s0[3] );
        LOC(_r+=2,_c);

        /* --------------------------- */
        /*      Wait for CR            */
```

```
/* --------------------------- */

do
  _i=gc();
while
  (_i!=CR);

/* ----------------------------------- */
/*       Fill tubes for 30 seconds      */
/* ----------------------------------- */

time( &_init_t );
_init_t += 4;
_end_t = _init_t + (time_t)_FILL_TUBES_P3;

_displaycursor(_GCURSOROFF);
STC(_Light_Cyan);

do{
  time( &_current_t );
  LOC(_r,_c);
  _outtext( (_current_t & 1) ? "*" : " " );
  }

while
  ( (_current_t != _init_t) && !kbhit() );

SetP3( rp3_max );

do{
  LOC(_r,_c);
  sprintf( _buff, " 0:%02ld", _end_t-time( &_current_t ) );
  _outtext(_buff);
  }

while
  ( (_end_t != _current_t) && !kbhit() );

SetP3( 0.0 );

_displaycursor(_GCURSORON);

/* ----------------------------------------------------- */
/*       Display instructions for filling the beaker     */
/* ----------------------------------------------------- */

_r+=2;

STC(_Light_Green);
LOC(_r,_c); _outtext( _s1[0] );
LOC(++_r,_c); _outtext( _s1[1] );

/* --------------------------- */
/*       Wait for CR           */
/* --------------------------- */
```

```
do
  _i=gc();
while
  (_i!=CR);

/* ------------------------------------------ */
/*      Wait 4 seconds before starting        */
/* ------------------------------------------ */

_r+=2;  STC(_Light_Cyan);

time( &_init_t );
_init_t += 4;

_end_t = _init_t + (time_t)_FILL_BEAKER_P3;

_displaycursor(_GCURSOROFF);

do{
  time( &_current_t );
  LOC(_r,_c);
  _outtext( (_current_t & 1) ? "*" : " " );
  }

while
  ( (_init_t != _current_t) && !kbhit() );

/* ------------------- */
/*      Start          */
/* ------------------- */

SetP3( rp3_max );

do{
  _seconds = _end_t - time( &_current_t );
  _minutes = _seconds / 60;
  _seconds -= _minutes * 60;
  LOC(_r,_c);
  sprintf( _buff, "%2d:%02d", _minutes, _seconds );
  _outtext(_buff);
  }

while
  ( (_current_t != _end_t) && !kbhit() );

SetP3( 0.0 );

_displaycursor(_GCURSORON);

/* ------------------------------------------ */
/*      Ask how much fluid was pumped         */
/* ------------------------------------------ */

_r+=2;
```

```
        STC(_Light_Green);
        LOC(_r++,_c);
        _outtext( "How much fluid was pumped (ml) ?:" );

        _VP3:
        LOC(_r,_c); STC(_Black); SBC(_Light_Cyan);
        switch( GetFloat( &p3_vol, 10, _NEW ) ){
          case 0:       break;
          case ESC:     break;
          default:      goto _VP3;
          }

        /* ---------------------------- */
        /*      Calculate rp3_max       */
        /* ---------------------------- */

        rp3_max = ( p3_vol * 60.0 ) / _FILL_BEAKER_P3;

        SBC(_Blue);

        LOC(_r+=2,_c); STC(_Bright_White); _outtext("RP3_MAX changed to:
        sprintf( _buff, "%.3f", rp3_max );
        STC(_Light_Cyan); _outtext(_buff);

        while(kbhit());
        gc();
        return(-1);


}

float   _h4[1000];

int     Cal_PS()
{

        int     _i, _j, _x, _y, _plot;
        char    _buff[128];
        time_t  _t0, _t1;
        float   _new_h4, _old_h4, _delta_h4;
        FILE    *_fp;
        struct videoconfig      _vc;


        /*
        printf( "video mode: ");
        scanf( "%d", &_i );
        */

        /*
        for( _i=32; ; --_i){
          _setvideomode( _i );
          _getvideoconfig(&_vc);
```

```
  if( (_vc.numtextcols != 0) && (_vc.numxpixels != 0 ) )
    break;
  }
*/

_setvideomode(16);
_getvideoconfig(&_vc);

SBC(_Blue); CLS;
_setcolor((short)_Bright_White);

h4adc.n = 5000;
_displaycursor(_GCURSOROFF);

SetP4( rp4_max );
time( &_t1 );
_t1 += 1;

/* ------------------------------------ */
/*      Restart Here                     */
/* ------------------------------------ */

RESTART_X:

/*
_plot=-1;
_x=0;
_setcolor(_Blue);
CLS;
_floodfill( 10, 10, _Bright_White );
STC( _Light_Green );
LOC( 25, 1 );
_outtext( "<F1=Restart>  <F2=Save to File>  <Esc=Quit>" );
_setcolor(_Bright_White);
*/

for( _plot=0, _x=0, _i=0; _i != -1; ){

  /* -------------------------- */
  /*    Wait for Timer          */
  /* -------------------------- */

  do
    time( &_t0 );

  while
    (_t0 != _t1);

  _t1 = _t0 + 1;

  /* -------------------------- */
  /*    Collect Data            */
  /* -------------------------- */

  ReadADC( &h4adc );
```

```
_old_h4 = _new_h4;
_new_h4 = ( h4adc.volts - .996 ) * 5.0 / 3.984;
_delta_h4 = _new_h4 - _old_h4;

/* -------------------------- */
/*    Print to Screen         */
/* -------------------------- */

if( !_plot ){

  LOC( 10, 5 );
  sprintf( _buff, "New H4:    %10.3f", _new_h4 );
  _outtext( _buff );

  LOC( 11, 5 );
  sprintf( _buff, "Old H4:    %10.3f", _old_h4 );
  _outtext( _buff );

  LOC( 12, 5 );
  sprintf( _buff, "Delta H4:  %10.3f", _delta_h4 );
  _outtext( _buff );

  }

/* ---------------------------------- */
/*    Plot to Screen                  */
/* ---------------------------------- */

if( _plot && (_i < _vc.numxpixels ) ){

  _h4[_i++] = _new_h4;

  _y = ( ( 4.0 -_new_h4 ) / 4.0 ) * (float)_vc.numypixels;

  if( _y > _vc.numypixels )
    _y = _vc.numypixels;

  if( _y < 0 )
    _y = 0;

  if( _plot == -2 )
    _lineto( _x++, _y );

  else{
    _moveto( _x++, _y );
    _plot = -2;
    }

  }

/* ---------------------------------- */
/*    Check for KB Hit                */
/* ---------------------------------- */
```

```
        if( kbhit() ){

          switch( gc() ){

            case CR:  _plot=-1;
                      _x=0;
                      _setcolor((short)_Blue);
                      CLS;
                      _floodfill( 10, 10, (short)_Bright_White );
                      STC( _Light_Green );
                      SBC(_Blue);
                      LOC( 25, 1 );
                      _outtext( "<F1=Restart>  <F2=Save to File>  <Esc
                      _setcolor((short)_Bright_White);
                      break;

            case ESC: _fp = fopen( "h4.dat", "wt" );


                      for( _j=0; _j<_i; ++_j ){
                        fprintf( _fp, "%d, %f\n", _j, _h4[_j] );
                        }

                      fclose( _fp );

                      _i = -1;

                      break;

            default:  break;

            }

          }

        }

      _setvideomode( _DEFAULTMODE );

      _displaycursor(_GCURSORON);
      return( -1 );


}

int     Calibrate_Pressure_Sensor()
{

        int     _i, _r, _c;
        float   _v_hi, _v_lo;
        struct  rccoord _rc;
        char    _buff[128];

        static char     *_s0[9] = {
```

```
"       Pressure Sensor Calibration",

"  The pressure sensor may be calibrated by letting the tube",
"section just above the sensor fill with slurry while pump P4",
"is stopped.  Once the tube is full, the slurry flow into the",
"tube should be diverted to a drain.  Then striking [\x11\xc4\xd
"activate pump P4 at maximum speed.  As the level H4 drops, the"
"user should strike [\x11\xc4\xd9] twice more.  The first time w
"the level passes the 4\" mark of H4 and the second when it pass
"the 1\" mark of h4."    };

static char     *_s1[3] = {

"  When the H4 tube is full and flow into it",
"has been diverted, strike [\x11\xc4\xd9] to start pump",
"P4 and begin the calibration process." };

static char     *_s2[2] = {

"  Strike [\x11\xc4\xd9] when the slurry level",
"passes th 4\" mark. " };

static char     *_s3[2] = {

"  Now strike [\x11\xc4\xd9] when the slurry level",
"passes the 1\" mark. "};

_BOX pressbox = { 2,

                {       "    Calibrate Pressure Sensor    ",
                        "             Exit                " },
                        _Black, _White,
                        { "" },
                        -1, -1,
                        0, 1, (80-(67-34))/2, 0
                };

/* ------------------------------------------------------ */
/*      Display calibrate Pressure Sensor Options         */
/* ------------------------------------------------------ */

_DISPPSOPTIONS:

SBC(_Blue); CLS;

_r=2, _c=10;

STC(_Bright_White);
LOC(_r,_c); _outtext(_s0[0]);

STC(_Light_Green);
for( _i=1, _r+=2; _i<=8; ++_i ){
  LOC( _r++, _c );
  _outtext( _s0[_i] );
```

```
  }

pressbox.row = ++_r;
pressbox.col = _c;

/* ---------------------------- */
/*      Switch option           */
/* ---------------------------- */

_CALPS:

switch( PrintBox( &pressbox ) ){

  case 0:       _r = pressbox.row + pressbox.nstrings + 4;

                STC(_Bright_White);
                for( _i=0; _i<=2; ++_i ){
                  LOC(_r+_i,_c);
                  _outtext(_s1[_i]);
                  }

                /* ---------------------------- */
                /*      Wait for First CR       */
                /* ---------------------------- */

                while( gc() != CR );

                SetP4( rp4_max );

                STC(_Blue);
                for( _i=0; _i<=2; ++_i ){
                  LOC(_r+_i,_c);
                  _outtext(_s1[_i]);
                  }

                STC(_Bright_White);
                for( _i=0; _i<=1; ++_i ){
                  LOC(_r+_i,_c);
                  _outtext(_s2[_i]);
                  }

                /* ------------------------------------- */
                /*      Wait for CR at 4" mark           */
                /* ------------------------------------- */

                _rc = _gettextposition();
                _rc.col += 7;

                h4adc.n = 1000;
                ReadADC( &h4adc );

                while( !kbhit() ){
                  ReadADC( &h4adc ); _v_hi = h4adc.volts;
                  LOC( _rc.row, _rc.col );
                  STC( _Light_Cyan );
```

```
                    sprintf( _buff, "%10.3f", h4adc.volts );
                    _outtext( _buff );
                    }

                  gc();

                  STC(_Blue);
                  for( _i=0; _i<=1; ++_i ){
                    LOC(_r+_i,_c);
                    _outtext(_s2[_i]);
                    }

                  STC(_Bright_White);
                  for( _i=0; _i<=1; ++_i ){
                    LOC(_r+_i,_c);
                    _outtext(_s3[_i]);
                    }

                  /* ------------------------------------ */
                  /*       Wait for CR at 1" mark          */
                  /* ------------------------------------ */

                  while( gc() != CR );

                  ReadADC( &h4adc ); _v_lo = h4adc.volts;

                  STC(_Blue);
                  for( _i=0; _i<=1; ++_i ){
                    LOC(_r+_i,_c);
                    _outtext(_s3[_i]);
                    }

                  SetP4( 0.0 );
                  Calc_H4_Slope_Offset( _v_hi, _v_lo );
                  goto _CALPS;

          case 1:         break;

          }

        return(-1);


}

int     Calc_H4_Slope_Offset( float _v_hi, float _v_lo )
{

        char    _buff[128];
        float   _old_mh4, _old_bh4;

        /* ------------------------------------------ */
        /*      Calculate Calibration Constants        */
        /* ------------------------------------------ */
```

```
        _old_mh4 = mh4;
        _old_bh4 = bh4;


        mh4 = ( 4.0 - 1.0 ) / ( _v_hi - _v_lo );
        bh4 = 1.0 - _v_lo * mh4;

        STC(_Bright_White); CLS;
        sprintf( _buff,
                 "_v_lo: %.3f     _v_hi: %.3f    mh4: %.3f    bh4: %.3f",
                 _v_lo, _v_hi, mh4, bh4 );
        LOC(1,1);
        _outtext( _buff );
        gc();

        Write_H4_File();

        sprintf( _buff, "mh4 changed from %.3f to %.3f", _old_mh4, mh4 )
        LogSA(_buff);
        sprintf( _buff, "bh4 changed from %.3f to %.3f", _old_bh4, bh4 )
        LogSA(_buff);

        return(-1);

}

int     Calibrate_Opacity_Probe()
{

        int             _i, _r, _c, _stat;
        int             _row[16], _col[16], _valid[16];
        char            _buff[128];
        float           _entries[16];

        _BOX calopacbox = { 2,

                        {       "    Calibrate Opacity Meter    ",
                                "             Exit              " },
                                _Black, _White,
                                { "" },
                                -1, -1,
                                0, 1, (80-(65-34))/2, 0
                        };

        /* ---------------------------- */
        /*      Initialize Arrays       */
        /* ---------------------------- */

        for( _i=0; _i<=15; _i+=2 ){
          _row[_i]   = 7 + _i;
          _row[_i+1] = 7 + _i;
          _col[_i]   = 10;
          _col[_i+1] = 32;
          }
```

```
for( _i=0; _i<16; _i+=2 ){
  _entries[_i] = xsolids[_i/2];
  _entries[_i+1] = ysignal[_i/2];
  _valid[_i] = TRUE;
  _valid[_i+1] = TRUE;
  }

/* ------------------------------------ */
/*       Display Screen Text            */
/* ------------------------------------ */

SBC(_Blue);     CLS;

calopacbox.row = 2;
calopacbox.col = 10;

_CALOPACOPTION:

switch( PrintBox( &calopacbox ) ){

  case 0:         break;

  case 1:         return(0);

  default:        goto _CALOPACOPTION;

  }

/* ---------------------------- */
/*       Print Headers          */
/* ---------------------------- */

SBC( _Blue ); CLS;

STC( _Light_Cyan );
LOC( _r=2, _c=10 );
_outtext( "Input 8 pairs of X, Y data:" );

STC( _Bright_White );
LOC( _r+=2, _c );    _outtext(   "    X      " );
LOC( _r, _c+22);     _outtext(   "    Y      " );

STC( _Light_Green );
LOC( ++_r, _c );  _outtext( "Percent Solids" );
LOC( _r, _c+22 );   _outtext( "Log Ratio Volts" );

/* ---------------------------- */
/*       Display Active Keys    */
/* ---------------------------- */

LOC( 23, _col[0] );
STC( _Bright_White ); SBC( _Blue );
_outtext( "< TAB = Next Cell >  < SHIFT_TAB = Previous Cell > "
LOC( 24, _col[0] );
```

```
_outtext( "< CR = Accept >      < F1 = Accept All > " );

SetActiveKeys( TAB, SHIFT_TAB, FKEY1 );

/* ------------------------------------ */
/*      Display Current X, Y Values     */
/* ------------------------------------ */

SBC( _Light_Cyan );
STC( _Black );

for( _i=0; _i<16; ++_i ){
  LOC( _row[_i], _col[_i] );
  if( _valid[_i] == TRUE )
    sprintf( _buff, "%-10f", _entries[_i] );
  else
    sprintf( _buff, "          " );
  _outtext(_buff);
  }

/* ---------------------------- */
/*      Get X, Y Data           */
/* ---------------------------- */

for( _i=0; ; ){

  _NEXTENTRY:

  LOC( _row[_i], _col[_i] );

  _stat = GetFloat( &_entries[_i], 10,
          ( _valid[_i] == TRUE ) ? _REPLACE : _NEW );

  switch( _stat ){

    case ESC:           SBC(_Blue);
                        CLS;
                        return(-1);

    case 0:             _valid[_i] = TRUE;

                        if( ++_i == 16 )
                          _i=0;

                        goto _NEXTENTRY;

    case TAB:           if( ++_i == 16 )
                          _i=0;

                        goto _NEXTENTRY;

    case SHIFT_TAB:     if( --_i == -1 )
                          _i=15;

                        goto _NEXTENTRY;
```

```
        case FKEY1:          for( _i=0; _i<=7; ++_i ){
                               xsolids[_i] = _entries[_i*2];
                               ysignal[_i] = _entries[_i*2+1];
                               }

                             Write_Opacity_File();
                             LogSA( "Opacity Meter X, Y Table Entered

                             SBC(_Blue);
                             CLS;
                             return(-1);

        default:             goto _NEXTENTRY;

        }

      }

}
```

```
/* ***********************************************************************
/*  Files.C DOE S&ASH ANALYZER, B&W RDD 4554
/* ***********************************************************************

#include        < Stdio.H >
#include        < Colors.H >
#include        < Graph.H >
#include        < String.H >
#include        < StdLib.H >
#include        < Ctype.H >
#include        < Dos.H >

#include        "Sa.H"
#include        "Proto.H"

#define         N_RESERVED_FILES 8

char            *reserved_file_name[N_RESERVED_FILES] = { "H4.",
                                                          "P3.",
                                                          "P4.",
                                                          "OP.",
                                                          "LOG."
                                                          "SA.EXE",
                                                          "OPACCAL.PRN",
                                                          "CALDATA.PRN"

int     Read_Files()
{

        Read_H4_File();
        Read_P3_File();
        Read_P4_File();
        Read_Opacity_File();

        return(-1);

}

int     Write_Files()
{

        Write_H4_File();
        Write_P3_File();
        Write_P4_File();
        Write_Opacity_File();

        return(-1);
}

int     LogSA( char *_s )
{

        char    _buff[128], _file[128];
        struct  dosdate_t _date;
        struct  dostime_t _time;
```

```
FILE    *_lg;

/* ******************** */
/*      return(-1);     */
/* ******************** */

/* ------------------------------------ */
/*      Form File Name from Date        */
/* ------------------------------------ */

_dos_getdate( &_date );

sprintf( _file, "%02d%02d%02d.Log", _date.month, _date.day, ( _d

/* -------------------------------------------- */
/*      If it doesn't exist, initialize         */
/* -------------------------------------------- */

if( access( _file, 0 ) != 0 ){

  _lg = fopen( _file, "at" );

  if( _lg == NULL ){
    SBC(_Blue); STC(_Bright_White);
    LOC(1,1);
    _outtext( "Cannot Open \"%s\"", _file );
    gc();
    LeaveSa(1);
    }

  DateTimeString( _buff );

  fprintf( _lg, "DOE Sulfur & Ash\n" );
  fprintf( _lg, "Log File < %s >\n", _file );
  fprintf( _lg, "%s\n\n", _buff );

  }

/* ------------------------------------ */
/*      Else open for "Append Text"     */
/* ------------------------------------ */

else{

  _lg = fopen( _file, "at" );

  if( _lg == NULL ){
    SBC(_Blue); STC(_Bright_White);
    LOC(1,1);
    _outtext( "Cannot Open \"%s\"", _file );
    gc();
    LeaveSa(1);
    }

  }
```

```
        _dos_gettime( &_time );
        sprintf( _buff, "%02d:%02d:%02d - ",    _time.hour,
                                                _time.minute,
                                                _time.second );

        fprintf( _lg, "%s%s\n", _buff, _s );

        fclose(_lg);

        return(-1);

}

int     Read_H4_File()
{

        FILE    *_h4;
        char    _strng[83];
        int     _i;

        _h4 = fopen( "H4.", "rt" );

        if( _h4 == NULL ){
          CLS;
          STC(_Bright_White);
          _outtext( "ERROR Opening \"H4.\"" );
          gc();
          LeaveSa(1);
          }

        while( !feof(_h4) ){

          fgets( _strng, 80, _h4 );

          /*
          for( _i=0; _strng[_i] != 0x0a; ++_i );
          _strng[_i] = '\0';

          printf( "\n<%s>\t", _strng );
          */

          if( strncmp( _strng, "MH4", 3 ) == 0 ){
            sscanf( _strng, "%*s %f ", &mh4 );
            /* printf( "MH4 = %f", mh4 ); */
            continue;
            }

          if( strncmp( _strng, "BH4", 3 ) == 0 ){
            sscanf( _strng, "%*s %f ", &bh4 );
            /* printf( "BH4 = %f", bh4 ); */
            continue;
            }

          if( strncmp( _strng, "LH4_LO_LIMIT", 10 ) == 0 ){
```

```
    sscanf( _strng, "%*s %f ", &lh4_lo_limit );
    /* printf( "LH4_LO_LIMIT = %f", lh4_lo_limit ); */
    continue;
    }

  if( strncmp( _strng, "LH4_HI_LIMIT", 12 ) == 0 ){
    sscanf( _strng, "%*s %f ", &lh4_hi_limit );
    /* printf( "LH4_HI_LIMIT = %f", lh4_hi_limit ); */
    continue;
    }

  if( strncmp( _strng, "LH4_TARGET", 10 ) == 0 ){
    sscanf( _strng, "%*s %f ", &lh4_target );
    /* printf( "LH4_TARGET = %f", lh4_target ); */
    continue;
    }

  }

lh4_lo_limit = lh4_target - 0.1;
lh4_hi_limit = lh4_target + 0.1;

fclose(_h4);

return(-1);

}

int     Write_H4_File()
{

        FILE    *_h4;

        _h4 = fopen( "H4.", "wt" );

        if( _h4 == NULL ){
          CLS;
          STC(_Bright_White);
          _outtext( "ERROR Opening \"H4.\"" );
          gc();
          LeaveSa(1);
          }

        fprintf( _h4, "MH4              %f\n", mh4              );
        fprintf( _h4, "BH4              %f\n", bh4              );
        /*
        fprintf( _h4, "LH4_LO_LIMIT     %f\n", lh4_lo_limit       );
        fprintf( _h4, "LH4_HI_LIMIT     %f\n", lh4_hi_limit       );
        */
        fprintf( _h4, "LH4_TARGET       %f\n", lh4_target       );

        fclose(_h4);

        return(-1);
```

```
}

int     Read_P3_File()
{

        FILE    *_p3;
        char    _strng[83];
        int     _i;

        _p3 = fopen( "P3.", "rt" );

        if( _p3 == NULL ){
          CLS;
          STC(_Bright_White);
          _outtext( "ERROR Opening \"P3.\"" );
          gc();
          LeaveSa(1);
          }

        while( !feof(_p3) ){

          fgets( _strng, 80, _p3 );

          /*
          for( _i=0; _strng[_i] != 0x0a; ++_i );
          _strng[_i] = '\0';

          printf( "\n<%s>\t", _strng );
          */

          if( strncmp( _strng, "MP3", 3 ) == 0 ){
            sscanf( _strng, "%*s %f ", &mp3 );
            /* printf( "MP3 = %f", mp3 ); */
            continue;
            }

          if( strncmp( _strng, "BP3", 3 ) == 0 ){
            sscanf( _strng, "%*s %f ", &bp3 );
            /* printf( "BP3 = %f", bp3 ); */
            continue;
            }

          if( strncmp( _strng, "RP3_MAX", 7 ) == 0 ){
            sscanf( _strng, "%*s %f ", &rp3_max );
            /* printf( "RP3_MAX = %f", rp3_max ); */
            continue;
            }

          if( strncmp( _strng, "RP3_LO_SET", 10 ) == 0 ){
            sscanf( _strng, "%*s %f ", &rp3_lo_set );
            /* printf( "RP3_LO_SET = %f", rp3_lo_set ); */
            continue;
            }

          if( strncmp( _strng, "RP3_HI_SET", 10 ) == 0 ){
```

```
            sscanf( _strng, "%*s %f ", &rp3_hi_set );
            /* printf( "RP3_HI_SET = %f", rp3_hi_set ); */
            continue;
            }

          if( strncmp( _strng, "RP3_FLUSH_BITS", 14 ) == 0 ){
            sscanf( _strng, "%*s %d ", &rp3_flush_bits );
            /* printf( "RP3_FLUSH_BITS = %d", rp3_flush_bits ); */
            continue;
            }

          }

        fclose(_p3);

        return(-1);

}

int     Write_P3_File()
{

        FILE    *_p3;

        _p3 = fopen( "P3.", "wt" );

        if( _p3 == NULL ){
          CLS;
          STC(_Bright_White);
          _outtext( "ERROR Opening \"P3.\"" );
          gc();
          LeaveSa(1);
          }

        fprintf( _p3, "MP3              %f\n", mp3            );
        fprintf( _p3, "BP3              %f\n", bp3            );
        fprintf( _p3, "RP3_MAX          %f\n", rp3_max        );
        fprintf( _p3, "RP3_LO_SET       %f\n", rp3_lo_set     );
        fprintf( _p3, "RP3_HI_SET       %f\n", rp3_hi_set     );
        fprintf( _p3, "RP3_FLUSH_BITS   %d\n", rp3_flush_bits );

        fclose(_p3);

        return(-1);
}


int     Read_P4_File()
{

        FILE    *_p4;
        char    _strng[83];
        int     _i;

        _p4 = fopen( "P4.", "rt" );
```

```
        if( _p4 == NULL ){
          CLS;
          STC(_Bright_White);
          _outtext( "ERROR Opening \"P4.\"" );
          gc();
          LeaveSa(1);
          }

        while( !feof(_p4) ){

          fgets( _strng, 80, _p4 );

          /*
          for( _i=0; _strng[_i] != 0x0a; ++_i );
          _strng[_i] = '\0';

          printf( "\n<%s>\t", _strng );
          */

          if( strncmp( _strng, "MP4", 3 ) == 0 ){
            sscanf( _strng, "%*s %f ", &mp4 );
            /* printf( "MP4 = %f", mp4 ); */
            continue;
            }

          if( strncmp( _strng, "BP4", 3 ) == 0 ){
            sscanf( _strng, "%*s %f ", &bp4 );
            /* printf( "BP4 = %f", bp4 ); */
            continue;
            }

          if( strncmp( _strng, "RP4_MAX", 7 ) == 0 ){
            sscanf( _strng, "%*s %f ", &rp4_max );
            /* printf( "RP4_MAX = %f", rp4_max ); */
            continue;
            }

          if( strncmp( _strng, "RP4_TARGET", 10 ) == 0 ){
            sscanf( _strng, "%*s %f ", &rp4_target );
            /* printf( "RP4_TARGET = %f", rp4_target ); */
            continue;
            }

          }

        fclose(_p4);

        return(-1);

}

int     Write_P4_File()
{
```

```
        FILE    *_p4;

        _p4 = fopen( "P4.", "wt" );

        if( _p4 == NULL ){
          CLS;
          STC(_Bright_White);
          _outtext( "ERROR Opening \"P4.\"" );
          gc();
          LeaveSa(1);
          }

        fprintf( _p4, "MP4         %f\n", mp4              );
        fprintf( _p4, "BP4         %f\n", bp4              );
        fprintf( _p4, "RP4_MAX     %f\n", rp4_max          );
        fprintf( _p4, "RP4_TARGET %f\n", rp4_target        );

        fclose(_p4);

        return(-1);
}

int     Read_Opacity_File()
{

        FILE    *_op;
        char    _strng[83];
        int     _i;

        _op = fopen( "Op.", "rt" );

        if( _op == NULL ){
          CLS;
          STC(_Bright_White);
          _outtext( "ERROR Opening \"Op.\"" );
          gc();
          LeaveSa(1);
          }

        while( !feof(_op) ){

          fgets( _strng, 80, _op );

          if( strncmp( _strng, "XY", 2 ) == 0 ){
            sscanf( &_strng[2], "%d ", &_i );
            sscanf( _strng, "%*s %f %f ", &xsolids[_i], &ysignal[_i] );
            continue;
            }

          if( strncmp( _strng, "INCREASE_P3", 11 ) == 0 ){
            sscanf( _strng, "%*s %d ", &increase_p3_t );
            continue;
            }

          if( strncmp( _strng, "READ_BACKGROUND", 15 ) == 0 ){
```

```
      sscanf( _strng, "%*s %d ", &background_t );
      continue;
      }

    if( strncmp( _strng, "READ_OPACITY", 12 ) == 0 ){
      sscanf( _strng, "%*s %d ", &read_opacity_t );
      continue;
      }

    if( strncmp( _strng, "FLUSH", 5 ) == 0 ){
      sscanf( _strng, "%*s %d ", &flush_t );
      continue;
      }

    if( strncmp( _strng, "DECREASE_P3", 11 ) == 0 ){
      sscanf( _strng, "%*s %d ", &decrease_p3_t );
      continue;
      }

    if( strncmp( _strng, "OPACITY_WEIGHT", 14 ) == 0 ){
      sscanf( _strng, "%*s %f ", &opacity_weight );
      continue;
      }

    if( strncmp( _strng, "PERCENT_SOLIDS", 14 ) == 0 ){
      sscanf( _strng, "%*s %f ", &percent_solids );
      continue;
      }

    if( strncmp( _strng, "P4_CAL_RATE", 11 ) == 0 ){
      sscanf( _strng, "%*s %f ", &p4_cal_rate );
      continue;
      }

    if( strncmp( _strng, "B0", 2 ) == 0 ){
      sscanf( _strng, "%*s %f ", &b0 );
      continue;
      }

    if( strncmp( _strng, "B1", 2 ) == 0 ){
      sscanf( _strng, "%*s %f ", &b1 );
      continue;
      }

    if( strncmp( _strng, "B2", 2 ) == 0 ){
      sscanf( _strng, "%*s %f ", &b2 );
      continue;
      }

    }

  fclose(_op);
  return(-1);

}
```

```
int     Write_Opacity_File()
{

        FILE    *_op;
        int     _i;

        _op = fopen( "Op.", "wt" );

        if( _op == NULL ){
          CLS;
          STC(_Bright_White);
          _outtext( "ERROR Opening \"Op.\"" );
          gc();
          LeaveSa(1);
          }

        for( _i=0; _i<8; ++_i )
          fprintf( _op, "XY%d %f %f\n", _i, xsolids[_i], ysignal[_i] );

        fprintf( _op, "INCREASE_P3           %d\n", increase_p3_t );
        fprintf( _op, "READ_BACKGROUND       %d\n", background_t );
        fprintf( _op, "READ_OPACITY          %d\n", read_opacity_t );
        fprintf( _op, "FLUSH                 %d\n", flush_t );
        fprintf( _op, "DECREASE_P3           %d\n", decrease_p3_t );
        fprintf( _op, "OPACITY_WEIGHT        %f\n", opacity_weight );
        fprintf( _op, "PERCENT_SOLIDS        %f\n", percent_solids );
        fprintf( _op, "P4_CAL_RATE           %f\n", p4_cal_rate );
        fprintf( _op, "B0                    %f\n", b0 );
        fprintf( _op, "B1                    %f\n", b1 );
        fprintf( _op, "B2                    %f\n", b2 );

        fclose(_op);

        return(-1);

}

int     Is_Reserved_File( char *_f )
{

        int             _i;

        char            _fdrive[_MAX_DRIVE], _fdir[_MAX_DIR];
        char            _fname[_MAX_FNAME], _fext[_MAX_EXT];

        char            _rdrive[_MAX_DRIVE], _rdir[_MAX_DIR];
        char            _rname[_MAX_FNAME], _rext[_MAX_EXT];

        _splitpath( _f, _fdrive, _fdir, _fname, _fext );

        for( _i=0; (_fext[_i]!='\0'); ++_i ){
          if( isspace( _fext[_i] ) ){
            _fext[_i] = '\0';
            break;
```

```
            }
          }

        if( strlen( _fext ) == 0 )
          strcpy( _fext, "." );

        for( _i=0; (_fname[_i]!='\0'); ++_i ){
          if( isspace( _fname[_i] ) ){
            _fname[_i] = '\0';
            break;
            }
          }


        for( _i=0; _i<N_RESERVED_FILES; ++_i ){

          _splitpath( reserved_file_name[_i], _rdrive, _rdir, _rname, _r

          if( (stricmp( _fname, _rname )==0) && (stricmp( _fext, _rext )
            return(-1);
            }

          }

        return(0);

}
```

```
/**************************************************************************
/*
/*      GRAPHS.C
/*      DOE S & ASH ANALYZER, B&W RDD 4554
/**************************************************************************
#include        < Graph.H >
#include        < Colors.H >
#include        < Keys.H >
#include        < Malloc.H >
#include        < ConIo.H >

#include        "Sa.H"
#include        "Proto.H"

int     Scope( _ADC *_b );

        _BOX _plotbox =         { 4,

                                {       "    Pressure Sensor    ",
                                        "     Opacity Meter     ",
                                        "         Aux.          ",
                                        "  Return to Main Menu  "
                        _Black, _White,

                        { "Plots:" },
                        _Light_Cyan, -1,

                        0, 12, ( 80 - ( 65 - 42 ) ) / 2.0, 0

int     Plot()
{

        while( -1 ){

          _setvideomode( _DEFAULTMODE );

          SBC(_Blue); STC(_White); CLS; Start_Up_Message();

          SetActiveKeys(0);

          switch( PrintBox( &_plotbox ) ){

            case 0:     Scope( &h4adc );
                        break;

            case 1:     Scope( &opadc );
                        break;

            case 2:     Scope( &aux );
                        break;

            case ESC:
            case 3:     CLS;
                        return(-1);
```

```
        default:    break;

        }

      }
}


int     Scope( _ADC *_b )
{

        struct  videoconfig     _vc;
        int                     _i, _j, _k, _n, _key, *_points, *_lookup

        /* ---------------------------------------------- */
        /*      Set video mode to highest possible        */
        /* ---------------------------------------------- */

        _vc.mode = 64;

        while( !_setvideomode( --_vc.mode ) );

        _displaycursor( _GCURSOROFF );

        _getvideoconfig( &_vc );

        _setcolor( (short)_Blue );
        _floodfill( 1, 1, (short)_Bright_White );

        /* ---------------------------- */
        /*      Allocate Memory         */
        /* ---------------------------- */

        _points = malloc( sizeof(int) * _vc.numxpixels * 8 );
        _lookup = malloc( sizeof(int) * 4096 );

        /* ---------------------------- */
        /*      Fill in Lookup Table    */
        /* ---------------------------- */

        for( _i=0; _i<4096; ++_i ){
          _lookup[_i] = (4095.0 - (float)_i) * ((float)_vc.numypixels /
          }

        /* ---------------------------- */
        /*      Draw Y Scale            */
        /* ---------------------------- */

        /*
        _setcolor( _Light_Green );

        for( _i = _vc.numypixels - 1; _i > 0; --_i ){
```

```
    _setpixel(0,_i);
    _setpixel(_vc.numxpixels-1,_i);

    if( (_i%8) == 0 ){

      for( _j=1; _j<10; ++_j ){
        _setpixel( _j, _i );
        _setpixel( _vc.numxpixels-10+_j, _i );
        }

      }

    }
  */

  /* --------------------------------------------------------- */
  /*      Select Gain & Channel for FastReadADC()              */
  /* --------------------------------------------------------- */

  #ifdef ADC_INSTALLED
    outp( ADC_CONTROL, _b->channel );
    outp( ADC_GAIN_CONTROL, _b->gain );
  #endif

  /* ---------------------------- */
  /*      Loop                    */
  /* ---------------------------- */

  for( _key = CR-1, _n = 1; _key != CR; ){

    /***************************************
    for( _i=0; _i< vc.numxpixels; ++_i ){
      _setcolor(_Blue);
      _setpixel(_i,_points[_i]);
      _points[_i] = _lookup[ FastReadADC() ];
      _setcolor(_Bright_White);
      _setpixel(_i,_points[_i]);
      }
    ***************************************/

    /*    _i      0 to x          inc 1          */
    /*    _j      0 to 4          inc 1          */
    /*    _k      0 to 4 * x      inc 4          */

    for( _i=0, _k=0; _i<_vc.numxpixels; ++_i, _k += _n ){

      for( _j=0; _j<_n; ++_j ){

        _setcolor((short)_Blue);
        _setpixel( _i, _points[ _k + _j ] );

        _points[ _k + _j ] = _lookup[ FastReadADC() ];

        _setcolor((short)_Bright_White);
        _setpixel( _i, _points[ _k + _j ] );
```

```
        }

      }

    if( kbhit() ){
      switch( _key = gc() ){

        case FKEY3:
        case FKEY4:         for( _i=0, _k=0, _setcolor((short)_Blue)
                              for( _j=0; _j<_n; ++_j ){
                                _setpixel( _i, _points[ _k + _j ] );
                                }
                              }

                            if( (_key == FKEY3) && ( _n > 1 ) ){
                              --_n;
                              break;
                              }

                            if( (_key == FKEY4) && ( _n < 8 ) ){
                              ++_n;
                              break;
                              }

        case CR:            break;

        }
      }

    }

  /* ---------------------------- */
  /*      Return                  */
  /* ---------------------------- */

  _setvideomode(_DEFAULTMODE);
  _displaycursor( _GCURSORON );

  SBC(_Blue);
  CLS;

  free( _points );
  free( _lookup );

  return(-1);

}
```

```
/* **********************************************************************
/*
/*      Operate.C
/*      DOE S & ASH ANALYZER, B&W RDD 4554
/* **********************************************************************

#include        < Graph.H >
#include        < Colors.H >
#include        < Keys.H >
#include        < StdIo.H >
#include        < Conio.H >
#include        < String.H >
#include        < CType.H >
#include        < Dos.H >
#include        < Math.H >
#include        < Time.H >

#include        "Sa.H"
#include        "Proto.H"

#define _P4_WEIGHT 10.0
#define _P4_UPDATE_RATE 2.0
#define _P4_UPDATE_PERCENT 0.75
#define _P4_TOLERANCE 0.16
#define _CONE_RADIUS 1.0
#define _DELTA_H4_M 0.1884
#define _H4_WEIGHT 25.0

#define _READ_CHAR_ATTRIBUTE 8
#define _WRITE_CHAR_ATTRIBUTE 9
#define _CURRENT_VIDEO_STATE 15
#define _VIDEO_INT 0x10
#define _BLACK_ON_WHITE 0x70
#define _WHITE_ON_BLACK 0xf

extern char     test_title[];


#define _BARGR_MIN 1
#define _BARGR_MAX 75
#define _BARGR_LO_SET 18
#define _BARGR_TARGET 38
#define _BARGR_HI_SET 56

#define _BARGR_WIDTH 77

#ifndef YES
#define YES -1
#endif

#ifndef NO
#define NO 0
#endif

int     Read_Opacity(   int     _volts_row,
```

```
                                int     _volts_col,
                                int     _date_row,
                                int     _date_col,
                                int     _msg_row,
                                int     _msg_col,
                                int     _et_row,
                                int     _et_col,
                                int     _bargr_row,
                                int     _bargr_col,
                                char    *_msg,
                                int     _t,
                                _ADC    *_adc           );


int     increase_p3_t;
int     background_t;
int     read_opacity_t;
int     flush_t;
int     decrease_p3_t;

int     _bargr_row, _bargr_col;
float   _h4_bar;


static char *_bargr[9] = {

/*           1         2         3         4         5         6         7
 01234567890123456789012345678901234567890123456789012345678901234567890
"ZDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
"3 Min                                H4 Level
"CDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
"3 Min                              P4 Pump Speed
"CDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
"3 Min                              P3 Pump Speed
"CDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
"3 Min                              Opacity Meter
"@DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
};

int     UpdateBarGraph( int _row, int _col, float _f );

int     Operate()
{

        int             _i, _r, _c, _operate, _display_page;
        char            _buff[256];
        time_t          _last_t, _current_t, _end_t, _loop_start_t;
        time_t          _last_p4_update, _next_p4_update;
        union REGS      _reg;
        float           _p4_rate, _delta_p4_rate, _p4_x, _p4_avg;
        float           _h4_new, _h4_old, _delta_h4, _delta_rp4;
        float           _opacity_sum, _bar, _qx, _correction, _slds;
        struct rccoord  _rc[8];
        unsigned long   _opacity_count;
```

```
static char     *_s0[6] = {

"  The sampling system should be operating and the level of the"
"fluid at \"H4\" should be between the limits of min and max val
"of H4 printed above.  If it is not, please bring it within thes
"limits by diverting the supply tube and/or opening the hand ope
"drain, Then hit [\x11\xc4\xd9] - The computer now believes the
"of H4 to be: " };

/* ------------------------------------ */
/*      Write to Log File               */
/* ------------------------------------ */

LogSA( "Operate Mode ------------------" );

sprintf( _buff, " P3 Max.       = %.3f mL/min.", rp3_max );
LogSA( _buff );

sprintf( _buff, " P3 High       = %.3f mL/min.", rp3_hi_set );
LogSA( _buff );

sprintf( _buff, " P3 Low        = %.3f mL/min.", rp3_lo_set );
LogSA( _buff );

sprintf( _buff, " P4 Max.       = %.3f mL/min.", rp4_max );
LogSA( _buff );

sprintf( _buff, " Inc. P3       = %d sec.", increase_p3_t );
LogSA( _buff );

sprintf( _buff, " Read Bckgrnd = %d sec.", background_t );
LogSA( _buff );

sprintf( _buff, " Read Opacity = %d sec.", read_opacity_t );
LogSA( _buff );

sprintf( _buff, " Flush         = %d sec.", flush_t );
LogSA( _buff );

/* ------------------------------------ */
/*      Print Start Up Message          */
/* ------------------------------------ */

SBC(_Blue); STC(_White); CLS; Start_Up_Message();
_rc[0] = _gettextposition(); _r=_rc[0].row; _c=_rc[0].col;

/* ------------------------------------ */
/*      Print Test Title, Date & Time   */
/* ------------------------------------ */

STC(_Light_Cyan);
LOC( _r, ( 80 - strlen( test_title ) ) / 2 );
_outtext(test_title);
```

```
DateTimeString( _buff );
STC(_Light_Cyan);
LOC(_r+1, ( 80 - strlen( _buff ) ) / 2 ); _outtext( _buff );

/* ---------------------------- */
/*      Print Parameters        */
/* ---------------------------- */

_r+=3;
_c=10;

STC(_Bright_White);
LOC(_r++,_c+2);
_outtext( "Parameters have been set to: ");

STC(_Light_Green);
LOC(_r++,_c);
_outtext( "Metering pump P3 background flow rate: " );
sprintf( _buff, "%.3f", rp3_lo_set );
STC(_Bright_White); _outtext(_buff);
STC(_Light_Green); _outtext( " ml/min. " );

LOC(_r++,_c);
_outtext( "Metering pump P3 opacity reading flow rate: " );
sprintf( _buff, "%.3f", rp3_hi_set );
STC(_Bright_White); _outtext(_buff);
STC(_Light_Green); _outtext( " ml/min.");

LOC(_r++,_c);
_outtext( "Peristaltic pump P4 expected average flow rate: ");
sprintf( _buff, "%.3f", rp4_target );
STC(_Bright_White); _outtext(_buff);
STC(_Light_Green); _outtext( " ml/min." );

LOC(_r++,_c);
_outtext( "Minimum value of H4: ");
sprintf( _buff, "%.3f", lh4_lo_limit );
STC(_Bright_White); _outtext(_buff);
STC(_Light_Green); _outtext( " inches" );

LOC(_r++,_c);
_outtext( "Maximum value of H4: ");
sprintf( _buff, "%.3f", lh4_hi_limit );
STC(_Bright_White); _outtext(_buff);
STC(_Light_Green); _outtext( " inches" );

LOC(++_r,_c);
STC(_Bright_White);
_outtext( "< Press any key to continue >" );

gc();

/* ------------------------------------ */
/*      Adjust H4 fluid level           */
/* ------------------------------------ */
```

```
STC(_Light_Green);

for( _i=0; _i<6; ++_i ){
  LOC(_r++,_c);
  _outtext(_s0[_i]);
  }

_rc[0] = _gettextposition();
_outtext( "            Inches      ");

_rc[1] = _gettextposition();
_outtext( "            Volts" );

SBC(_Blue); STC(_Bright_White);
_displaycursor(_GCURSOROFF);

/* ------------------------------------ */
/*      Display real-time level         */
/* ------------------------------------ */

h4adc.n = 1000;

_DISPLREALTIME:

while( !kbhit() ){
  ReadADC( &h4adc );
  /* h4_level = h4adc.volts * mh4 + bh4; */
  h4_level = ( h4adc.volts - .996 ) * ( 5.0 / 3.984 );
  LOC(_rc[0].row,_rc[0].col);
  sprintf( _buff, "%10f", h4_level );
  _outtext( _buff );
  LOC(_rc[1].row,_rc[1].col);
  sprintf( _buff, "%10f", h4adc.volts );
  _outtext(_buff);
  }

if( gc() != CR )
  goto _DISPLREALTIME;

/* ============================================ */
/*              Operate Loop                    */
/* ============================================ */

/* ------------------------------------ */
/*      Print Header & Labels           */
/* ------------------------------------ */

SBC(_Blue); STC(_Light_Cyan); CLS; Start_Up_Message();

_rc[0] = _gettextposition();

DateTimeString( _buff );
_rc[3].row = _rc[0].row;
_rc[3].col = ( ( 80.0 - (float)strlen(_buff) ) / 2.0 );
```

```
_r = _rc[3].row + 2;
_c = 5;

_reg.h.ah = _CURRENT_VIDEO_STATE;
int86( _VIDEO_INT, &_reg, &_reg );
_display_page = _reg.h.bh & 0xff;

STC(_Bright_White);
LOC( _r, _c ); _outtext( "[\x11\xc4\xd9] Take an opacity reading
LOC( ++_r, _c ); _outtext( "[ESC] Exit" );
_rc[4].row = _r+1;    _rc[4].col = _c;
_rc[5].row = _r+1;    _rc[5].col = _c+26;

STC(_Light_Green);

LOC( --_r, _c=45 ); _outtext( "H4 Level:       " );
_rc[0] = _gettextposition();
_outtext( "            inches" );

LOC( ++_r, _c ); _outtext( "Pump P4 speed: " );
_rc[1] = _gettextposition();
_outtext( "            ml/min" );

LOC( ++_r, _c ); _outtext( "Opacity Meter: " );
_rc[2] = _gettextposition();
_outtext( "            volts" );

LOC( ++_r, _c ); _outtext( "Solids:        " );
_rc[6] = _gettextposition();

LOC( ++_r, _c ); _outtext( "Valve V1:      " );
_rc[7] = _gettextposition();

SBC(_White); STC(_Black);
for( _i=0, _bargr_row = 16, _bargr_col=((80-_BARGR_WIDTH)/2+1);
  LOC( _bargr_row + _i,  _bargr_col ); _outtext( _bargr[_i] );
  }

SBC(_Blue); STC(_Light_Magenta);
LOC( _bargr_row - 2, _bargr_col + _BARGR_LO_SET - 7 );
sprintf( _buff, "Lo Set: %.3f\"", lh4_lo_limit );
_outtext( _buff );

LOC( _bargr_row - 2, _bargr_col + _BARGR_TARGET - 7 );
sprintf( _buff, "Target: %.3f\"", lh4_target );
_outtext( _buff );

LOC( _bargr_row - 2, _bargr_col + _BARGR_HI_SET - 7 );
sprintf( _buff, "Hi Set: %.3f\"", lh4_hi_limit );
_outtext( _buff );

STC(_Yellow);
LOC( _bargr_row - 1, _bargr_col + _BARGR_LO_SET );
sprintf( _buff, "%c", 25 );
```

```
_outtext( _buff );

LOC( _bargr_row - 1, _bargr_col + _BARGR_TARGET );
sprintf( _buff, "%c", 25 );
_outtext( _buff );

LOC( _bargr_row - 1, _bargr_col + _BARGR_HI_SET );
sprintf( _buff, "%c", 25 );
_outtext( _buff );

SetP3( rp3_lo_set );
_bar  =  rp3_lo_set / rp3_max;
_bar *= ( _BARGR_MAX.0 - _BARGR_MIN.0 );
_bar += _BARGR_MIN.0;
UpdateBarGraph( _bargr_row+5, _bargr_col, _bar );

_p4_rate = rp4_target;
_p4_avg  = _p4_rate;

SetP4( _p4_rate );

_bar  =  _p4_rate / rp4_max;
_bar *= ( _BARGR_MAX.0 - _BARGR_MIN.0 );
_bar += _BARGR_MIN.0;
UpdateBarGraph( _bargr_row+3, _bargr_col, _bar );
time( &_last_p4_update );
_next_p4_update = _last_p4_update + (time_t)_P4_UPDATE_RATE;

h4adc.n = 1000;
ReadADC( &h4adc );
/* _h4_old = h4adc.volts * mh4 + bh4; */
_h4_old = ( h4adc.volts - .996 ) * ( 5.0 / 3.984 );

/* **************************************************** */
/*                START OF CONTINUOUS LOOP              */
/* **************************************************** */

_ADJUSTP4:

SBC(_Blue);
STC(_Bright_White);
              time( &_loop_start_t );

for( _operate = 0; _operate != ESC;  ){

  /* ---------------------------------------- */
  /*            Display Time & Date           */
  /* ---------------------------------------- */

  LOC( _rc[3].row, _rc[3].col );
  STC(_Light_Green); SBC(_Blue);
  DateTimeString(_buff);
  _outtext(_buff);

  /* -------------------------------- */
```

7

```
/*              Read H4                  */
/* ---------------------------------- */

ReadADC( &h4adc );
_h4_new = ( h4adc.volts - .996 ) * ( 5.0 / 3.984 );
h4_level = _h4_new;

/* ---------------------------------- */
/*              Adjust P4                */
/* ---------------------------------- */

time( &_current_t );

/*
LOC( 5, 1 ); printf( "current_t: %10ld", _current_t );
LOC( 6, 1 ); printf( "next_p4:   %10ld", _next_p4_update );
*/

if( _current_t == _next_p4_update ){

  /* ---------------------------------------- */
  /*           If H4 is outside limits         */
  /* ---------------------------------------- */

  if( (h4_level > lh4_hi_limit) || (h4_level < lh4_lo_limit) )

    if( h4_level > lh4_hi_limit )
      SetP4( rp4_max );

    else
      SetP4( 0.0 );

    }

  /* ---------------------------------------- */
  /*           If H4 is within limits          */
  /* ---------------------------------------- */

  else{

    GetP4( &_p4_rate );

    /*
    LOC( 1, 1 ); printf( "Old: %10.3f", _h4_old );
    LOC( 2, 1 ); printf( "New: %10.3f", _h4_new );
    */

    /*
    _delta_p4_rate = 2.54 * 60.0 * (_h4_new-_h4_old) * 3.1417
    _delta_p4_rate /= ( 3.0 * _P4_UPDATE_RATE );
    _p4_rate += ( _P4_UPDATE_PERCENT * _delta_p4_rate );
    */

    _delta_p4_rate = (_h4_new-_h4_old) * 5.0 / _DELTA_H4_M;
   _p4_rate += ( _P4_UPDATE_PERCENT * _delta_p4_rate );
```

```
    /*
    LOC( 5, 1 ); printf( "Corr:%10.3f", _correction );

    LOC( 3, 1 ); printf( "P4:  %10.3f", _p4_rate );
    LOC( 4, 1 ); printf( "dP4: %10.3f", _delta_p4_rate );
    */

    SetP4( _p4_rate );

    _p4_avg *= ( _P4_WEIGHT - 1.0 );
    _p4_avg += _p4_rate;
    _p4_avg /= _P4_WEIGHT;

    }

  _next_p4_update     = _current_t + (time_t)_P4_UPDATE_RATE;
  _last_p4_update     = _current_t;

  _h4_old = _h4_new;

  }

/* ------------------------------------------ */
/*          Update Screen Data                */
/* ------------------------------------------ */

STC(_Bright_White); SBC(_Blue);

sprintf( _buff, "%10.3f", h4_level );
LOC( _rc[0].row, _rc[0].col );
_outtext( _buff );

GetP4( &_p4_rate );

sprintf( _buff, "%10.3f", _p4_rate );
LOC( _rc[1].row, _rc[1].col );
_outtext( _buff );

/* ------------------------------------------ */
/*          Update H4 Bar Graph               */
/* ------------------------------------------ */

_h4_bar  = (h4_level - lh4_lo_limit);
_h4_bar *= (_BARGR_HI_SET.0 - _BARGR_LO_SET.0);
_h4_bar /= (lh4_hi_limit - lh4_lo_limit);
_h4_bar += _BARGR_LO_SET.0;

if( _h4_bar > _BARGR_MAX )
  _h4_bar = _BARGR_MAX;

if( _h4_bar < _BARGR_MIN )
  _h4_bar = _BARGR_MIN;

UpdateBarGraph( _bargr_row+1, _bargr_col, _h4_bar );
```

```
/* ------------------------------------------ */
/*            Update P4 Bar Graph             */
/* ------------------------------------------ */

GetP4( &_p4_rate );

_p4_x =  _p4_rate / rp4_max;
_p4_x *= ( _BARGR_MAX.0 - _BARGR_MIN.0 );
_p4_x += _BARGR_MIN.0;

UpdateBarGraph( _bargr_row+3, _bargr_col, _p4_x );

/* ------------------------------------------ */
/*            Update Opacity Bar Graph        */
/* ------------------------------------------ */

opadc.n = 1000;
ReadADC( &opadc );

opadc.bits  -= opadcbk.bits;
opadc.volts -= opadcbk.volts;

_bar  = opadc.bits / opadc.fs_bits;
_bar *= ( _BARGR_MAX.0 - _BARGR_MIN.0 );
_bar += _BARGR_MIN;

UpdateBarGraph( _bargr_row+7, _bargr_col, _bar );

LOC( _rc[2].row, _rc[2].col );
sprintf( _buff, "%10.3f", opadc.volts );
STC(_Bright_White);
SBC(_Blue);
_outtext(_buff);


/* ------------------------------------------ */
/*            If Keyboard Hit                 */
/* ------------------------------------------ */

if( kbhit() ){
  switch( _operate = gc() ){

    case ESC:          SetP4( _p4_avg );
                       _displaycursor(_GCURSORON);
                       STC(_Light_Green);
                       SBC(_Blue);
                       CLS;
                       return(-1);

    case CR:           LogSA( "Reading Opacity -------------"

                       /* ---------------------------- */
                       /*      Set P4 to _p4_avg       */
                       /* ---------------------------- */
```

```
_p4_rate = _p4_avg;
SetP4( _p4_rate );

sprintf( _buff, "  P4 set to %.3f mL/min
LogSA( _buff );

_p4_x =  _p4_rate / rp4_max;
_p4_x *= ( _BARGR_MAX.0 - _BARGR_MIN.0 )
_p4_x += _BARGR_MIN.0;

UpdateBarGraph( _bargr_row+3, _bargr_col

sprintf( _buff, "%10.3f", _p4_rate );
LOC( _rc[1].row, _rc[1].col );
_outtext( _buff );

/* -------------------------- */
/*      Increase P3 Flow      */
/* -------------------------- */

SetP3( rp3_hi_set );
_bar  =  rp3_hi_set / rp3_max;
_bar *= ( _BARGR_MAX.0 - _BARGR_MIN.0 );
_bar += _BARGR_MIN.0;
UpdateBarGraph( _bargr_row+5, _bargr_col

Read_Opacity(   _rc[2].row, _rc[2].col,
                _rc[3].row, _rc[3].col,
                _rc[4].row, _rc[4].col,
                _rc[5].row, _rc[5].col,
                _bargr_row+7, _bargr_col
                " P3 flow rate increased
                increase_p3_t,
                &opadc  );

/* ----------------------------------
/*      Take Background Reading
/* ----------------------------------

Read_Opacity(   _rc[2].row, _rc[2].col,
                _rc[3].row, _rc[3].col,
                _rc[4].row, _rc[4].col,
                _rc[5].row, _rc[5].col,
                _bargr_row+7, _bargr_col
                " Reading background ",
                background_t,
                &opadcbk  );

sprintf( _buff, "  Background: %.4f",
opadcbk.volts );
LogSA( _buff );

/* -------------------------- */
/*      Open Valve V1         */
```

```
/* ---------------------------- */

SetV1( _V1_OPEN );
LOC(_rc[7].row,_rc[7].col);
STC(_Yellow); SBC(_Blue);
_outtext( "     Meter" );

/* ------------------------------------
/*      Read Opacity for 60 Seconds
/* ------------------------------------

Read_Opacity(   _rc[2].row, _rc[2].col,
                _rc[3].row, _rc[3].col,
                _rc[4].row, _rc[4].col,
                _rc[5].row, _rc[5].col,
                _bargr_row+7, _bargr_col
                " Reading Opacity ",
                read_opacity_t,
                &opadc   );

sprintf( _buff, "  Opacity: %.4f", opadc
LogSA( _buff );

/* ---------------------------- */
/*      Calculate Solids        */
/* ---------------------------- */

_slds = Opacity_To_Solids( &rp3_hi_set,
                           &_p4_rate,
                           &opadc.volts

LOC(_rc[6].row,_rc[6].col);
sprintf( _buff, "%10.3f", _slds );
_outtext( _buff );

/* ---------------------------- */
/*      Close Valve V1          */
/* ---------------------------- */

SetV1( _V1_CLOSE );
LOC(_rc[7].row,_rc[7].col);
STC(_Yellow); SBC(_Blue);
_outtext( "     Drain" );

/* ---------------------------- */
/*      Flush for 120 Seconds   */
/* ---------------------------- */

Read_Opacity(   _rc[2].row, _rc[2].col,
                _rc[3].row, _rc[3].col,
                _rc[4].row, _rc[4].col,
                _rc[5].row, _rc[5].col,
                _bargr_row+7, _bargr_col
                " Flushing ",
                flush_t,
```

```
                                              &opadc  );

                                /* ---------------------------- */
                                /*      Decrease P3 Flow,       */
                                /* ---------------------------- */

                                SetP3( rp3_lo_set );

                                _bar  =  rp3_lo_set / rp3_max;
                                _bar *= ( _BARGR_MAX.0 - _BARGR_MIN.0 );
                                _bar += _BARGR_MIN.0;
                                UpdateBarGraph( _bargr_row+5, _bargr_col

                                time( &_next_p4_update );
                                _next_p4_update += 1;

                                break;

                default:        break;

                }
              }

           goto _ADJUSTP4;

           }

}

int     Read_Opacity(   int     _volts_row,
                        int     _volts_col,
                        int     _date_row,
                        int     _date_col,
                        int     _msg_row,
                        int     _msg_col,
                        int     _et_row,
                        int     _et_col,
                        int     _bargr_row,
                        int     _bargr_col,
                        char    *_msg,
                        int     _t,
                        _ADC    *_adc          )
{

        time_t  _end_t, _current_t;
        int     _min, _sec;
        int     _i;
        float   _bar;
        char    _buff[128];

        /* ------------------------------------ */
        /*      Print Message                   */
        /* ------------------------------------ */
```

```
STC( _Bright_White );
SBC( _Red );
LOC( _msg_row, _msg_col );
_outtext( _msg );

time( &_current_t );
_end_t = _current_t + _t;

while( (_end_t - _current_t) > 0 ){

  /* ------------------------- */
  /*    Print Date & Time      */
  /* ------------------------- */

  DateTimeString( _buff );
  STC( _Light_Green );
  SBC( _Blue );
  LOC( _date_row, _date_col );
  _outtext( _buff );

  /* ------------------------- */
  /*    Print Elapsed Time     */
  /* ------------------------- */

  time( &_current_t );

  _min = ( _end_t - _current_t ) / 60.0;
  _sec = ( _end_t - _current_t ) - ( _min * 60 );

  LOC( _et_row, _et_col );
  sprintf( _buff, "%2d:%02d", _min, _sec );
  _outtext( _buff );

  /* --------------------------------- */
  /*    Read Opacity                   */
  /* --------------------------------- */

  _adc -> n = 1000;
  ReadADC( _adc );

  if( _adc != &opadcbk ){
    _adc -> bits -= opadcbk.bits;
    _adc -> volts -= opadcbk.volts;
  }

  _bar  = _adc -> bits / _adc -> fs_bits;
  _bar *= ( _BARGR_MAX.0 - _BARGR_MIN.0 );
  _bar += _BARGR_MIN;
  UpdateBarGraph( _bargr_row, _bargr_col, _bar );

  LOC( _volts_row, _volts_col );
  sprintf( _buff, "%10.3f", _adc->volts );
  STC(_Bright_White);
  SBC(_Blue);
  _outtext(_buff);
```

```
    if( kbhit() ){
      gc();
      break;
      }

    }

  /* ------------------------------------ */
  /*    Clear Message & Elapsed Time      */
  /* ------------------------------------ */

  _i = ( _et_col - _msg_col ) + 5;
  _buff[_i--] = '\0';

  for( ; _i>=0; --_i )
    _buff[_i] = ' ';

  LOC( _msg_row, _msg_col );
  SBC( _Blue );
  _outtext( _buff );

  /* ---------------------------- */
  /*      Return                  */
  /* ---------------------------- */

  return(-1);

}

int     DateTimeString( char *_s )
{

  struct dosdate_t        _date;
  struct dostime_t        _time;

  static char     *_months[12] = {

                  "January", "February", "March", "April",
                  "May", "June", "July", "August",
                  "September", "October", "November", "December"

  static char     *_day[7] = {

                  "Sunday", "Monday", "Tuesday", "Wednesday",
                  "Thursday", "Friday", "Saturday"        };

  _dos_getdate( &_date ); _dos_gettime( &_time );

  sprintf( _s, "%s - %s %d, %d     %02d:%02d:%02d",

                                    _day[_date.dayofweek],
                                    _months[_date.month-1],
                                    _date.day,
                                    _date.year,
```

```
                                        _time.hour,
                                        _time.minute,
                                        _time.second );

        return(-1);

}

UpdateBarGraph( int _row, int _col, float _p4_x )
{

        union REGS   _reg;
        int          _i, _display_page;

        _reg.h.ah = _CURRENT_VIDEO_STATE;
        int86( _VIDEO_INT, &_reg, &_reg );
        _display_page = _reg.h.bh & 0xff;

        for( _i = _BARGR_MIN; _i < _p4_x; ++_i ){

          LOC( _row, _col+_i );

          _reg.h.ah = _READ_CHAR_ATTRIBUTE;
          _reg.h.bh = _display_page;
          int86( _VIDEO_INT, &_reg, &_reg );

          _reg.h.ah = _WRITE_CHAR_ATTRIBUTE;
          _reg.h.bh = _display_page;
          _reg.h.bl = _WHITE_ON_BLACK;
          _reg.x.cx = 1;
          int86( _VIDEO_INT, &_reg, &_reg );

          }

        for( ; _i <= _BARGR_MAX; ++_i ){

          LOC( _row, _col+_i );

          _reg.h.ah = _READ_CHAR_ATTRIBUTE;
          _reg.h.bh = _display_page;
          int86( _VIDEO_INT, &_reg, &_reg );

          _reg.h.ah = _WRITE_CHAR_ATTRIBUTE;
          _reg.h.bh = _display_page;
          _reg.h.bl = _BLACK_ON_WHITE;
          _reg.x.cx = 1;
          int86( _VIDEO_INT, &_reg, &_reg );

          }

}

float   Opacity_To_Solids(      float *_P3_rate,
                                float *_P4_rate,
                                float *_opacity        )
```

```
double   _d0, _d1;
float    _solids_f;

/************************************************************

EQUATION 1:

Y = A0 + A1 * X + A2 * X^2          Y (Opacity) AS A FUNCTION
                                    OF X (% Solids).


EQUATION 2:

Y = B0 + B1 * ( X - B2 )^2          SAME EQUATION, DIFFERENT FORM.


EQUATION 3:

X = B2 +- ( ( Y - B0 ) / B1 )^0.5         FORM USED TO CALCULATE
                                          Solids AS A FUNCTION
                                          OF Opacity.

************************************************************/


_d0 = ( *_opacity - b0 ) / b1;

if( _d0 < +0.0 )
  return( _solids_f = +0.0 );

_d1 = ( sqrt( _d0 ) * -1.0 ) + b2;

_d1 *= ( ( *_P3_rate + *_P4_rate ) / *_P4_rate );

_solids_f = _d1;

return( _solids_f );
```

```
/* ********************************************************************
/*      SA.C, DOE S & ASH ANALYZER, RDD 4554
/* ********************************************************************

#include        < Graph.H >
#include        < Stdio.H >
#include        < StdLib.H >
#include        < ConIo.H >
#include        < Colors.H >
#include        < Keys.H >
#include        < String.H >
#include        < CType.H >
#include        < Math.H >

#include        "Sa.H"
#include        "Proto.H"

int             i, _row, _col;

short           default_textcolor;
long            default_bkcolor;

int             active_key[8] = {-1,-1,-1,-1,-1,-1,-1,-1};

                /* ---------------------------- */
                /*      Metering Pump P3        */
                /* ---------------------------- */

float           rp3_lo_set;            /* Background Flow Rate */
float           rp3_hi_set;            /* Opacity Reading Flow Rate */
float           mp3;
float           bp3;
float           rp3_max;
float           p3_vol;

                /* ---------------------------- */
                /*      Peristaltic Pump P4     */
                /* ---------------------------- */

float           rp4_target;            /* Expected Avg. Flow Rate */
float           rp4_max;               /* Maximum Flow Rate */
float           p4_vol;                /* Temporary Volume Variable */
float           mp4;
float           bp4;

                /* ---------------------------- */
                /*      Pressure Sensor         */
                /* ---------------------------- */

float           lh4_hi_limit;
float           lh4_target;
float           lh4_lo_limit;
float           mh4;                   /* Slope of V to P Equation */
float           bh4;                   /* Offset of V to P Equation */
float           h4_sig;                /* Raw signal */
```

```
float           h4_level;                  /* Level */
_ADC            h4adc;                     /* Data Acquisition Structure */

                /* --------------------------- */
                /*      Opacity Meter          */
                /* --------------------------- */

float           xsolids[8];
float           ysignal[8];

float           opacity_weight, b0 = 1.0, b1 = 1.0, b2 = 1.0;

_ADC            opadc;
_ADC            opadcbk;                   /* Data Acquisition Structures *

_BOX m1 =       { 6, {  "        Setup        ",
                        "      Calibrate      ",
                        "       Operate       ",
                        "        Plot         ",
                        "       DAC Out       ",
                        "        Exit         "  },
                        _Black, _White,

                        { "Main Menu:" },
                        _Light_Cyan, -1,

                        0, 12, 26, 0                              };

_ADC    aux;

main()
{

        default_textcolor = STC(_White);
        default_bkcolor   = SBC(_Blue);
        CLS;

        LogSA( "Enter Program" );
        Read_Files();
        Init_ADC();
        InitPIO24();

        MAIN_MENU:

        STC(_White); SBC(_Blue); Start_Up_Message();

        switch( PrintBox( &m1 ) ){

          case 0:       SetUp();
                        goto MAIN_MENU;

          case 1:       Calibrate();
                        goto MAIN_MENU;

          case 2:       Operate();
```

```
                        goto MAIN_MENU;

        case 3:         Plot();
                        goto MAIN_MENU;

        case 4:         OutDAC();
                        /* OutX(); */
                        goto MAIN_MENU;

        case 5:         LeaveSa(0);

        }

}

int     LeaveSa( int _ret_code )
{

        LogSA( "Leave Program\n" );
        Write_Files();
        SetP3( 0.0 );
        SetP4( 0.0 );
        InitPIO24();
        STC( default_textcolor );
        SBC( default_bkcolor );
        CURSOR_ON;
        CLS;
        exit(_ret_code);

}

int     PrintBox( _BOX *_b )
{

        short   _i, _tc, _box_width, _sel;
        long    _bk;
        char    _buff[80];

        _box_width = strlen( _b->s[0] ) + 4;

        _tc = _gettextcolor();
        _bk = _getbkcolor();

        if( _b->mtcolor != -1 )
          STC(_b->mtcolor);

        if( _b->mbkcolor!=-1 )
          SBC(_b->mbkcolor);

        LOC( _b->row-1, _b->col+((_box_width-strlen(_b->mname))/2) );
        OTXT( _b->mname );

        STC( _b->tcolor );
        SBC( _b->bkcolor );
```

```
_sel = _b->sel;

CURSOR_OFF;

/* ------------------------------------- */
/*      Top                              */
/* ------------------------------------- */

for( _i=2; _i<_box_width-2; _buff[_i++] = 'D' );
_buff[0] = ' '; _buff[1] = 'Z';
_buff[_box_width-2] = '?'; _buff[_box_width-1] = ' ';
_buff[_box_width] = '\0';

LOC( _b->row, _b->col );
OTXT( _buff );

/* ------------------------------------- */
/*      Sides                            */
/* ------------------------------------- */

for( _i=2; _i<_box_width-2; _buff[_i++] = ' ' );
_buff[1] = '3'; _buff[_box_width-2] = '3';

for( _i=1; _i<=_b->nstrings; ++_i ){
  LOC( _b->row+_i, _b->col );
  OTXT( _buff );
  }

/* ------------------------------------- */
/*      Bottom                           */
/* ------------------------------------- */

for( _i=2; _i<_box_width-2; _buff[_i++] = 'D' );
_buff[0] = ' '; _buff[1] = '@';
_buff[_box_width-2] = 'Y'; _buff[_box_width-1] = ' ';
_buff[_box_width] = '\0';
LOC( _b->row+_b->nstrings+1, _b->col );
OTXT( _buff );

/* ------------------------------------- */
/*      Strings                          */
/* ------------------------------------- */

for( _i=0; _i<_b->nstrings; ++_i ){
  LOC( _b->row+_i+1, _b->col+2 );
  OTXT( _b->s[_i] );
  }

/* ------------------------------------- */
/*      Highlight                        */
/* ------------------------------------- */

STC( _b->bkcolor );
SBC( _b->tcolor );
```

```
LOC( _b->row+_b->sel+1, _b->col+2 );
OTXT( _b->s[_b->sel] );

/* ---------------------------------------- */
/*      SWITCH character                    */
/* ---------------------------------------- */

SWITCH_AGAIN:

switch( gc() ){

  case UP_ARROW:          STC( _b->tcolor );
                          SBC( _b->bkcolor );
                          LOC( _b->row+_sel+1, _b->col+2 );
                          OTXT( _b->s[_sel] );

                          if( _sel == 0 )
                            _sel = _b->nstrings - 1;

                          else
                            --_sel;

                          STC( _b->bkcolor );
                          SBC( _b->tcolor );
                          LOC( _b->row+_sel+1, _b->col+2 );
                          OTXT( _b->s[_sel] );

                          goto SWITCH_AGAIN;

  case DOWN_ARROW:        STC( _b->tcolor );
                          SBC( _b->bkcolor );
                          LOC( _b->row+_sel+1, _b->col+2 );
                          OTXT( _b->s[_sel] );

                          if( _sel == _b->nstrings - 1 )
                            _sel = 0;

                          else
                            ++_sel;

                          STC( _b->bkcolor );
                          SBC( _b->tcolor );
                          LOC( _b->row+_sel+1, _b->col+2 );
                          OTXT( _b->s[_sel] );

                          goto SWITCH_AGAIN;

  case CR:                _b->sel = _sel;
                          break;

  case ESC:               _b->sel = _b->nstrings-1;
                          break;

  default:                goto SWITCH_AGAIN;
```

```
          }

        STC( _b->tcolor );
        SBC( _b->bkcolor );
        LOC( _b->row+_sel+1, _b->col+2 );
        OTXT( _b->s[_sel] );

        STC( _tc );
        SBC( _bk );

        CURSOR_ON;

        return(_b->sel);

}

int     gc()
{

        int     _k;

        _k = getch();

        if( _k != 0 )
          return( _k );

        else{

          _k = getch();
          _k <<= 8;

          /*
          if( _k == FKEY9 ){
            SetP3(0.0);
            SetP4(0.0);
            SetV1(_V1_DEFAULT);
            }
          */

          return(_k);
          }

}

#define _GS_WIDTH 256
#define _OVERWRITE 1
#define _INSERT 2

int     GetString( char *_s, int _field_width )
{

        char                _sbuff[_GS_WIDTH], _sdisp[_GS_WIDTH];
        struct rccoord      _rc;
        int                 _i, _j, _k, _insert_mode, _pbuff, _pdisp, _ps;
```

```
/* ------------------------------------ */
/*       Initialize Variables           */
/* ------------------------------------ */

_rc    = _gettextposition();

_ps    = 0;      /* _s[] index          */
_pbuff = 0;      /* _sbuff[] index      */
_pdisp = 0;      /* _sdisp[] index      */

/* ------------------------------------ */
/*       Set Cursor to Default          */
/* ------------------------------------ */

_insert_mode = _OVERWRITE;
_settextcursor( 0x0007 );

/* ------------------------------------ */
/*       Copy String to Local Buffer    */
/* ------------------------------------ */

_j = strlen( _s );
if( _j < _field_width ){
  do
    _s[_j] = ' ';
  while
    ( _j++ < _field_width );
  _s[_j] = '\0';
  }

strncpy( _sbuff, _s, _GS_WIDTH );

/* ------------------------------------ */
/*       Copy String to Print Buffer    */
/* ------------------------------------ */

sprintf( _sdisp, "%.*s", _field_width, _s );

/* ------------------------------------ */
/*       Print String                   */
/* ------------------------------------ */

OTXT( _sdisp );
LOC( _rc.row, _rc.col );

/* ------------------------------------ */
/*       Get a Character                */
/* ------------------------------------ */

_SWITCH_AGAIN:

CURSOR_ON;

switch( _k = gc() ){
```

```
CURSOR_OFF;

case INSERT:            if( _insert_mode == _INSERT ){
                          _insert_mode = _OVERWRITE;
                          _settextcursor( 0x0007 );
                          }

                        else{
                          _insert_mode = _INSERT;
                          _settextcursor( 0x0607 );
                          }

                        goto _SWITCH_AGAIN;

case DELETE:            if( _pdisp == _field_width )
                          goto _SWITCH_AGAIN;

                        strcpy( &_sbuff[_pbuff], &_sbuff[_pbuff+
                        strcpy( &_sdisp[_pdisp], &_sdisp[_pdisp+

                        strcat( &_sbuff[_pbuff], " " );
                        strcat( &_sdisp[_pdisp], " " );

                        LOC( _rc.row, _rc.col + _pdisp );
                        OTXT( &_sdisp[_pdisp] );
                        LOC( _rc.row, _rc.col + _pdisp );

                        goto _SWITCH_AGAIN;


case ESC:               _settextcursor( 0x0607 );
                        strcpy( _sdisp, _s );
                        LOC(_rc.row,_rc.col);
                        OTXT( _sdisp );
                        CURSOR_ON;
                        return( _k );

case CR:                _settextcursor( 0x0607 );
                        for( _i = 0; _sdisp[_i] == ' '; ++_i );
                        strcpy( _s, &_sdisp[_i] );
                        CURSOR_ON;
                        return( 0 );

case LEFT_ARROW:        if( _pbuff != 0 )
                          --_pbuff;

                        if( _pdisp != 0 )
                          --_pdisp;

                        else{
                          sprintf( _sdisp, "%.*s", _field_width,
                          OTXT( _sdisp );
                          }

                        LOC( _rc.row, _rc.col + _pdisp );
```

```
                        goto _SWITCH_AGAIN;

case RIGHT_ARROW:       if( _pbuff < (_GS_WIDTH-1) )
                          ++_pbuff;

                        if( _pdisp < _field_width )
                          ++_pdisp;

                        else{
                          sprintf( _sdisp, "%.*s", _field_width,
                          LOC( _rc.row, _rc.col );
                          strcat( &_sbuff[_pbuff-1], " " );
                          strcat( &_sdisp[_pdisp-1], " " );
                          OTXT( _sdisp );
                          }

                        LOC( _rc.row, _rc.col + _pdisp );

                        goto _SWITCH_AGAIN;

case BACKSPACE:         if( _pbuff > 0 ) --_pbuff;
                        if( _pdisp > 0 ) --_pdisp;

                        strcpy( &_sbuff[_pbuff], &_sbuff[_pbuff+
                        strcpy( &_sdisp[_pdisp], &_sdisp[_pdisp+

                        strcat( &_sbuff[_pbuff], " " );
                        strcat( &_sdisp[_pdisp], " " );

                        LOC( _rc.row, _rc.col + _pdisp );
                        OTXT( &_sdisp[_pdisp] );
                        LOC( _rc.row, _rc.col + _pdisp );

                        goto _SWITCH_AGAIN;


case HOME:              _pbuff -= _pdisp;
                        _pdisp  = 0;
                        LOC( _rc.row, _rc.col );

                        goto _SWITCH_AGAIN;

case END:               _pbuff += ( ( _field_width - 1 ) - _pdis
                        _pdisp  = _field_width - 1;
                        LOC( _rc.row, _rc.col + _pdisp );

                        goto _SWITCH_AGAIN;


case CTRL_HOME:         _pbuff = 0;
                        _pdisp = 0;
                        strncpy( _sdisp, _sbuff, _field_width );
                        LOC(_rc.row,_rc.col);
                        OTXT( _sdisp );
```

```
                    LOC(_rc.row,_rc.col);

                    goto _SWITCH_AGAIN;

      default:      for( _i=0; _i<8; ++_i ){
                      if( _k == active_key[_i] ){
                        _settextcursor( 0x0607 );

                        /*** This was added
                        for( _i = 0; _sdisp[_i] == ' '; ++_i
                        strcpy( _s, &_sdisp[_i] );
                        ***/

                        /*** This was removed ***/
                        strcpy( _sdisp, _s );

                        LOC(_rc.row,_rc.col);
                        OTXT( _sdisp );
                        CURSOR_ON;
                        return( _k );
                        }
                      }

                    if( isprint( _k ) ){

                      if( (_insert_mode == _OVERWRITE) && (_
                        _sbuff[_pbuff] = _k;
                        _sdisp[_pdisp] = _k;
                        _outchar( _k );
                        if( _pdisp < (_field_width-1) ){
                          ++_pdisp;
                          ++_pbuff;
                          }
                        if( _pdisp == (_field_width-1) )
                          LOC( _rc.row, _rc.col+(_field_widt
                        }

                      if( (_insert_mode == _INSERT)  && (_pd
                        _i = _pbuff;
                        while(_sbuff[++_i]!='\0');
                        if( _i < (_GS_WIDTH-1) ){

                          do{
                            _sbuff[_i+1] = _sbuff[_i];
                            --_i;
                            }
                          while
                            ( _i >= _pbuff );

                          _sbuff[_pbuff] = _k;

                          sprintf( &_sdisp[_pdisp], "%.*s",

                          LOC( _rc.row, _rc.col + _pdisp );
                          OTXT( &_sdisp[_pdisp] );
```

```
                                        ++_pbuff;
                                        ++_pdisp;

                                        LOC( _rc.row, _rc.col + _pdisp );

                                        }
                                      }

                                    }

                              goto _SWITCH_AGAIN;

          }

}

int     GetInt( int *_int, int _n, int _mode )
{

        int                         _i, _k, _d;
        char                        _s[128];
        struct rccoord              _rc;

        _rc = _gettextposition();

        /* -------------------------------------------- */
        /*      Convert Existing Integer to String      */
        /* -------------------------------------------- */

        if( (_mode == _REPLACE) || (_mode == _DISPLAY) )
          sprintf( _s, "%-*d", _n, *_int );

        else if( _mode == _NEW ){
          for( _k = 0; _k < _n; ++_k )
            _s[_k] = ' ';
          _s[_n] = '\0';
          }

        else return( -1 );

        /* -------------------- */
        /*      Get String      */
        /* -------------------- */

        _GS:

        LOC( _rc.row, _rc.col );

        if( _mode != _DISPLAY )
          _k = GetString( _s, _n );

        else
          _k = 0;
```

```
        switch( _k ){

          case ESC:                   return( _k );

          case 0:                     if( BlankString(_s) )
                                        return(-1);

                                      else{
                                        _d = atoi( _s );
                                        sprintf( _s, "%-*d", _n, _d );
                                        _s[_n] = '\0';
                                        *_int = _d;

                                        LOC( _rc.row, _rc.col );  OTXT( _s );
                                        LOC( _rc.row, _rc.col );

                                        return( 0 );
                                        }

          default:                    for( _i=0; _i<8; ++_i ){
                                        if( _k == active_key[_i] )
                                          return(_k);
                                        }

                                      goto _GS;

          }

}

int     GetFloat( float *_f, int _n, int _mode )
{


        int                           _i, _k;
        char                          _s[128];
        double                        _d;
        struct rccoord                _rc;

        _rc = _gettextposition();

        /* -------------------------------------------------------------
        /*      Convert Existing Float to String if _REPLACE_FLOAT
        /* -------------------------------------------------------------

        if( (_mode == _REPLACE) || (_mode == _DISPLAY) )
          sprintf( _s, "%-*f", _n, *_f );

        /* ------------------------------------------------ */
        /*      Create Blank String if _NEW_FLOAT           */
        /* ------------------------------------------------ */

        if( _mode == _NEW ){
          for( _k = 0; _k < _n; ++_k )
```

```
    _s[_k] = ' ';
  }

_s[_n] = '\0';

/* ------------------------------------ */
/*       Return -1 if Mode ERROR        */
/* ------------------------------------ */

if( (_mode != _REPLACE) && (_mode != _NEW) && (_mode != _DISPLAY
  return(-1);

/* -------------------- */
/*      Get String      */
/* -------------------- */

_GF:

LOC( _rc.row, _rc.col );

if( (_mode == _NEW) || (_mode == _REPLACE) )
  _k = GetString( _s, _n );

if( _mode == _DISPLAY )
  _k = 0;

switch( _k ){

  case ESC:              return( _k );

  case 0:                if( BlankString(_s) )
                           return(-1);

                         else{
                           _d = atof( _s );
                           sprintf( _s, "%-*f", _n, _d );
                           _s[_n] = '\0';
                           *_f = _d;

                           LOC( _rc.row, _rc.col );  OTXT( _s );
                           LOC( _rc.row, _rc.col );

                           return( 0 );
                           }

   default:              for( _i=0; _i<8; ++_i ){
                           if( _k == active_key[_i] )
                             return(_k);
                           }

                         goto _GF;

   }
```

```
int      SetActiveKeys(  int      _k0,
                         int      _k1,
                         int      _k2,
                         int      _k3,
                         int      _k4,
                         int      _k5,
                         int      _k6,
                         int      _k7       )
{
         int      _i;

         for( _i=0; _i<7; ++_i )
           active_key[_i] = -1;

         if( _k0 == 0 )
           return(-1);
         else
           active_key[0] = _k0;

         if( _k1 == 0 )
           return(-1);
         else
           active_key[1] = _k1;

         if( _k2 == 0 )
           return(-1);
         else
           active_key[2] = _k2;

         if( _k3 == 0 )
           return(-1);
         else
           active_key[3] = _k3;

         if( _k4 == 0 )
           return(-1);
         else
           active_key[4] = _k4;

         if( _k5 == 0 )
           return(-1);
         else
           active_key[5] = _k5;

         if( _k6 == 0 )
           return(-1);
         else
           active_key[6] = _k6;

         if( _k7 == 0 )
           return(-1);
         else
           active_key[7] = _k7;
```

```
        return(-1);


}

int     _outchar( int _k )
{

        char    _s[2];

        _s[0] = _k;
        _s[1] = '\0';
        OTXT( _s );

}

int     Start_Up_Message()
{

int             _i, _r, _c;

static char     *start_up_msg[4] = {

                "                  Babcock & Wilcox                    ",
                "     AMTEC - Applied Measurement Technologies         ",
                "              Sulfur and Ash Analyzer                 ",
                "  Copyright (C) 1990, The Babcock & Wilcox Company    "

                };

        for( _i=0, _r=2, _c=(80-strlen(start_up_msg[0]))/2; _i<4; ++_i )
          LOC( _r++, _c );
          OTXT( start_up_msg[_i] );
          }

        LOC( ++_r, _c );

        return(-1);

}

int     BlankString( char *_s )
{

                int     _i;

                _i=0;

                while( isspace( _s[_i++] ) );

                return ( _s[--_i] == '\0' ) ? -1 : 0;

}
```

```
/* ====================================================================
/*      SA.H, DOE S & ASH ANALYZER, B&W RDD 4554
/* ====================================================================

struct _adc     {         float   v_range;
                          float   v_offset;
                          float   fs_bits;
                          float   b_offset;
                          float   volts;
                          int     bits;
                          int     channel;
                          int     gain;
                          int     n;
                };

#define         _ADC    struct _adc

extern short    default_textcolor;
extern long     default_bkcolor;

extern _ADC     opadc, opadcbk, h4adc, aux;

extern float    rp3_lo_set, rp3_hi_set, mp3, bp3, rp3_max, p3_vol;
extern float    rp4_target, rp4_max, mp4, bp4, p4_vol;
extern float    lh4_lo_limit, lh4_hi_limit, lh4_target, h4_sig, h4_level
extern float    xsolids[], ysignal[], opacity_weight;
extern int      increase_p3_t;
extern int      background_t;
extern int      read_opacity_t;
extern int      flush_t;
extern int      decrease_p3_t;
extern int      rp3_flush_bits;
extern float    percent_solids, p4_cal_rate;
extern float    b0, b1, b2;

#define         _DEBUG -1

#define         TRUE    -1
#define         FALSE   0

#define         _BOX_STRING_MAX 16

#define         _BOX    struct box

_BOX            {         int     nstrings;
                          char    *s[24];
                          short   tcolor;
                          long    bkcolor;
                          char    *mname;
                          short   mtcolor;
                          long    mbkcolor;
                          int     sel;
                          int     row;
                          int     col;
                          int     mode;
```

```
};

#define         _REPLACE        1
#define         _NEW            2
#define         _DISPLAY        4

#define         CURSOR_ON       _displaycursor(_GCURSORON)
#define         CURSOR_OFF      _displaycursor(_GCURSOROFF)

#define         LOC(a,b)        _settextposition(a,b)
#define         STC(c)          _settextcolor((short)c)
#define         SBC(c)          _setbkcolor((long)c)
#define         OTXT(t)         _outtext(t)
#define         CLS             _clearscreen(0)

#define         CRS             \x11\xc4\xd9

/* -------------------( PIO-24 Parallel Port )------------------------

#define                 PIO_INSTALLED   1

#define                 PIO_BASE        0x348
#define                 PA              PIO_BASE
#define                 PB              PIO_BASE+1
#define                 PC              PIO_BASE+2
#define                 PIO_CONTROL     PIO_BASE+3

#define                 _V1_OPEN  1
#define                 _V1_CLOSE 0
#define                 _V1_DEFAULT 0

/* -------------------( DDA-06 D/A Converter )------------------------

#define                 DAC_INSTALLED           1

#define                 DDA06_BASE              0x350

#define                 P3DAC_L8                DDA06_BASE
#define                 P3DAC_H4                DDA06_BASE+1

#define                 P4DAC_L8                DDA06_BASE+2
#define                 P4DAC_H4                DDA06_BASE+3

#define                 STRIP_CHART_L8          DDA06_BASE+6
#define                 STRIP_CHART_H4          DDA06_BASE+7

#define                 P3_LO                   19
#define                 P3_HI                   18

#define                 P4_LO                   17
#define                 P4_HI                   16

/* -------------------( DAS8-PGA A/D Converter )----------------------
```

```
#define    ADC_INSTALLED              1

#define    DAS8PGA_BASE               0x340

#define    ADC_L4                     DAS8PGA_BASE
#define    ADC_H8                     DAS8PGA_BASE+1
#define    ADC_STATUS                 DAS8PGA_BASE+2
#define    ADC_STATUS_AND_GAIN        DAS8PGA_BASE+3   /* Read

#define    ADC_START_8_BIT            DAS8PGA_BASE
#define    ADC_START_12_BIT           DAS8PGA_BASE+1
#define    ADC_CONTROL                DAS8PGA_BASE+2
#define    ADC_GAIN_CONTROL           DAS8PGA_BASE+3   /* Write

#define    ADC_BITS                   4096.0
#define    ADC_RANGE                  10.0
#define    ADC_OFFSET                 2048.0

#define    ADC_GAIN_CONTROL_BYTE      0         /* 5 Volts Bipol

#define    BIPOLAR_5V                 0
#define    BIPOLAR_10V                8
#define    UNIPOLAR_10V               9

#define    GAIN_1                     0xff
#define    GAIN_10                    0xef
#define    GAIN_100                   0xdf
#define    GAIN_500                   0xcf

#define    ADC_H4_PRESSURE_SENSOR     0
#define    ADC_AUX                    1
#define    ADC_OPACITY_METER          2
```

```c
/*************************************************************************
/*
/*      SAIO.C
/*      DOE S & ASH ANALYZER, B&W RDD 4554
/*************************************************************************

#include        < StdIo.H >
#include        < Conio.H >
#include        < Colors.H >
#include        < Graph.H >
#include        < Keys.H >
#include        < Time.H >

#include        "Sa.H"
#include        "Proto.H"

int     StripChartOut( float _volts );

extern char     name_out[], test_title[];

int     rp3_flush_bits;
int     strip_bits;
float   strip_volts;

char    *_cb = " Value out of range Calibration Boy ";
char    *_bl = "                                    ";

float   _$p3_rate;
float   _$p4_rate;
int     _$v1;

float   percent_solids;
float   p4_cal_rate;
int     _nfmi;
int     _fmi_bits[100];
float   _fmi_rate[100];
float   _solids[100];

#define TIME_COL 0
#define FMI_RATE_COL 5
#define SOLIDS_COL 15
#define BKGRND_COL 25
#define OPAC_COL 35

int     AutoOpacCal()
{

        FILE    *_aoc, *_df;

        int     _i, _j, _r, _c, _fmi, _nfmi, _graphics_mode;
        int     _gx1, _gx2, _gy1, _gy2, _x1, _y1;
        time_t  _start_t, _current_t, _prev_t;
        float   _new_bk, _old_bk, _new_opac, _old_opac, _max_opacity;
        char    _buff[128];
```

```
struct  videoconfig _vc, _vc_sav;

_getvideoconfig( &_vc_sav );

if( _setvideomode( _ERESCOLOR ) ){
  _getvideoconfig( &_vc );
  _graphics_mode = _ERESCOLOR;

  _gx1 = 2 * (_vc.numxpixels / 3 ) - 64;
  _gx2 = _vc.numxpixels - 1;
  _gy1 = 0;
  _gy2 = _vc.numypixels - 1;

  }

else{
  _graphics_mode = 0;
  }

/*
printf( "Mode:           %d\n", _graphics_mode );
printf( "Text Rows:      %d\n", _vc.numtextrows );
printf( "Text Columns:   %d\n", _vc.numtextcols );
printf( "X Pixels:       %d\n", _vc.numxpixels );
printf( "Y Pixels:       %d\n", _vc.numypixels );
gc();
*/

SBC(_Blue);
CLS;
CURSOR_OFF;

_new_bk = 0.0;
_old_bk = 0.0;
_new_opac = 0.0;
_old_opac = 0.0;

/* -------------------------------------------- */
/*      Print Header                             */
/* -------------------------------------------- */

STC(_Light_Green);
LOC( _r=1, _c=1 );
/*              1         2         3         4         5
/*     1234567890123456789012345678901234567890123456789012345 67
OTXT( "Time  FMI rate    Solids    Bkgrnd   Opacity" );

++_r;

if( _graphics_mode == _ERESCOLOR ){

  /*
  CLS;

  for( _i=0, _gx1=10, _gx2=10, _gy1=10, _gy2=100;
```

```
        _i<_vc.numcolors;
        ++_i, _gx1+=10, _gx2+=10 ){

      _setcolor(_i);
      _moveto( _gx1, _gy1 );
      _lineto( _gx2, _gy2 );

      }

   gc();
   */

   _moveto( _gx1, _gy1 );
   _lineto( _gx2, _gy1 );
   _lineto( _gx2, _gy2 );
   _lineto( _gx1, _gy2 );
   _lineto( _gx1, _gy1 );
   _moveto( _gx1, _gy2 );
   _setcolor( _Blue );
   _floodfill( (_gx1+1), (_gy1+1), _Bright_White );
   _setcliprgn( _gx1, _gy1, _gx2, _gy2 );
   }

/* --------------------------------------------- */
/*      Open Data File                           */
/* --------------------------------------------- */

if( BlankString( name_out ) ){
  strcpy( name_out, "CalData.Prn" );
  strcpy( test_title, "Default Test Data" );
  }

_df = fopen( name_out, "wt" );

if( _df == NULL ){
  _setvideomode( _vc_sav.mode );
  return(0);
  }

fprintf( _df, "\"%s\"\n\n", test_title );

fprintf( _df, "\"     Bits\",\" FMI Rate\",\"   Solids\",\"   Bk

/* --------------------------------------------- */
/*      Read FMI Pump rates from file            */
/* --------------------------------------------- */

_aoc = fopen( "OpacCal.Prn", "rt" );

if( _aoc == NULL ){
  _setvideomode( _vc_sav.mode );
  return(0);
  }

/* fscanf( _aoc, "%f %f ", &percent_solids, &p4_cal_rate ); */
```

```
for( _fmi = 0; (!feof(_aoc)) && (_fmi<100); ++_fmi ){
  fscanf( _aoc, "%d %f ", &_fmi_bits[_fmi], &_fmi_rate[_fmi] );
  }

fclose(_aoc);

_nfmi = _fmi;

/* ------------------------------------------------ */
/*      Calculate Solids Array                      */
/* ------------------------------------------------ */

/*
sprintf( _buff, "Percent Solids: %10.3f", percent_solids );
LOC( ++_r, _c=10 );
OTXT( _buff );

sprintf( _buff, "P4 Rate:        %10.3f", p4_cal_rate    );
LOC( ++_r, _c=10 );
OTXT( _buff );
*/

for( _fmi=0, ++_r, _c=10; _fmi < _nfmi; ++_fmi ){

  _solids[_fmi]  = p4_cal_rate / ( p4_cal_rate + _fmi_rate[_fmi]
  _solids[_fmi] *= percent_solids;

  sprintf( _buff, "%10d", _fmi_bits[_fmi] );
  LOC( _r + _fmi, FMI_RATE_COL );
  OTXT( _buff );

  sprintf( _buff, "%10.4f", _solids[_fmi] );
  LOC( _r + _fmi, SOLIDS_COL );
  OTXT( _buff );

  }

  /*
  CURSOR_ON;
  gc();
  return(-1);
  */

 _fmi = 0;

 /* _settextwindow( 2, 1, 5, 46 ); */

 START_CAL_CYCLE:
 STC(_Bright_White);

 /* ------------------------------------------------ */
 /*      Set FMI Pump to rp3_flush_bits              */
 /*      Set Peristaltic Pump to 0                   */
 /*      Close Valve                                 */
```

```
/* ------------------------------------------ */

SetP3( ( (float)rp3_flush_bits/4095.0 ) * rp3_max );
SetP4(0.0);
SetV1(_V1_CLOSE);

LOC(_r, FMI_RATE_COL );
sprintf( _buff, "%10d", rp3_flush_bits );
OTXT( _buff );

LOC(_r, SOLIDS_COL );
sprintf( _buff, "%10.4f", _solids[_fmi] );
OTXT( _buff );

/* ------------------------------------------ */
/*      Wait for flush_t                      */
/* ------------------------------------------ */

time( &_start_t );
_prev_t = _start_t - 1L;

do{

  time( &_current_t);

  LOC( _r, TIME_COL );
  sprintf( _buff, "%4Ld", flush_t - (_current_t-_start_t) );
  OTXT( _buff );

  if( _current_t != _prev_t ){
    _prev_t = _current_t;
    }

  if(kbhit()){
    gc();
    break;
    }

  }

while
  ( (_current_t - _start_t) < flush_t );

/* ------------------------------------------ */
/*      Read Background for background_t      */
/* ------------------------------------------ */

SetP3( ( (float)_fmi_bits[_fmi]/4095.0) * rp3_max );

LOC(_r, FMI_RATE_COL );
sprintf( _buff, "%10d", _fmi_bits[_fmi] );
OTXT( _buff );

opadcbk.n = 10;
```

```
time( &_start_t );
_prev_t = _start_t - 1L;

do{

  time( &_current_t);

  ReadADC( &opadcbk );

  /*
  #ifndef ADC_INSTALLED
    opadcbk.volts = (short)( (_current_t-_start_t) * 5.0 );
  #endif
  */

  _new_bk  = opadcbk.volts;
  _new_bk += _old_bk * ( opacity_weight - 1.0 );
  _new_bk /= opacity_weight;

  _old_bk  = _new_bk;

  LOC( _r, TIME_COL );
  sprintf( _buff, "%4Ld", background_t - (_current_t-_start_t) )
  OTXT( _buff );

  LOC( _r, BKGRND_COL );
  sprintf( _buff, "%10.3f", _new_bk );
  OTXT( _buff );

  strip_volts = (_new_bk + 10.0) * 4095.0 / 20.0;
  StripChartOut( strip_volts );

  if( _current_t != _prev_t ){
    _prev_t = _current_t;
    }

  if(kbhit()){
    gc();
    break;
    }

  }

while
  ( (_current_t - _start_t) < background_t );

/* ------------------------------------------- */
/*      Set FMI Pump to _fmi_bits[]            */
/*      Set Peristaltic Pump to p4_cal_rate    */
/*      Open Valve                             */
/* ------------------------------------------- */

SetP3( ( (float)_fmi_bits[_fmi] / 4095.0 ) * rp3_max );
SetP4( p4_cal_rate );
SetV1(_V1_OPEN);
```

```
LOC(_r, FMI_RATE_COL );
sprintf( _buff, "%10d", _fmi_bits[_fmi] );
OTXT( _buff );

/* ------------------------------------------ */
/*      Read Opacity for read_opacity_t       */
/* ------------------------------------------ */

STC(_Bright_White);

opadc.n = 10;

time( &_start_t );
_prev_t = _start_t - 1L;

do{

  time( &_current_t);

  ReadADC( &opadc );

  /*
  #ifndef ADC_INSTALLED
    opadc.volts = (short)( (_current_t-_start_t) * 5.0 );
  #endif
  */

  _new_opac  = opadc.volts;
  _new_opac += _old_opac * ( opacity_weight - 1.0 );
  _new_opac /= opacity_weight;

  _old_opac  = _new_opac;

  LOC( _r, TIME_COL );
  sprintf( _buff, "%4Ld", read_opacity_t - (_current_t-_start_t)
  OTXT( _buff );

  LOC( _r, OPAC_COL );
  sprintf( _buff, "%10.3f", (_new_opac - _new_bk)  );
  OTXT( _buff );

  strip_volts = (_new_opac - _new_bk + 10.0) * 4095.0 / 20.0;
  StripChartOut( strip_volts );

  if( _current_t != _prev_t ){
    _prev_t = _current_t;
    }

  if(kbhit()){
    break;
    }

  }
```

```
while
  ( (_current_t - _start_t) < read_opacity_t );

/* ----------------------------------- */
/*      Store to file                  */
/* ----------------------------------- */

fprintf( _df,
         "%d, %.3f, %.4f, %.3f, %.3f\n",
         _fmi_bits[_fmi],
         _fmi_rate[_fmi],
         _solids[_fmi],
         _new_bk,
         (_new_opac-_new_bk) );

/* ----------------------------------- */
/*      Plot                           */
/* ----------------------------------- */

if( _graphics_mode == _ERESCOLOR ){

  if( _fmi == 0 ){

    _max_opacity = 1.25 * ( _new_opac - _new_bk );

    if( _max_opacity < 0.0 )
      _max_opacity = 1.0;

    }

  _x1 = (float)_gx1 + ( ( (float)_fmi + 1.0 ) / ((float)_nfmi +
  _y1 = (float)_gy2 - (_new_opac-_new_bk) * ( (float)_gy2 - (flc

  #ifndef ADC_INSTALLED

    _y1 = ( _gy2 - _gy1 ) / ( (float)(_nfmi - _fmi) + 1.25 );

  #endif

  _setcolor( _Light_Cyan );

  if( _fmi == 0 )
    _moveto( _x1, _y1 );

  else
    _lineto( _x1, _y1 );

  _setcolor( _Bright_White );
  _ellipse( _GBORDER, (_x1-3), (_y1-3), (_x1+3), (_y1+3) );

  }

/* ----------------------------------- */
/*      Finished / Kb Hit ?            */
/* ----------------------------------- */
```

```
        if( kbhit() ){

          SetP3( 0.0 );
          SetP4( 0.0 );
          SetV1( _V1_DEFAULT );

          while( kbhit() )
            gc();

          LOC( 25, 1 );
          CURSOR_ON;
          sprintf( _buff, "Exit Auto-Calibration (Y/N) " );
          OTXT( _buff );

          _j = gc();

          CURSOR_OFF;

          if( (_j=='y') || (_j=='Y') )
            goto KB_EXIT;
          else{
            LOC(25, 1);
            OTXT( "                                        " );
            }
          }

        if( ++_fmi < _nfmi ){
          ++_r;
          goto START_CAL_CYCLE;
          }

        KB_EXIT:

        fflush( _df );
        fclose(_df);

        SetP3( 0.0 );
        SetP4( 0.0 );
        SetV1( _V1_DEFAULT );

        LOC(25,79);
        CURSOR_ON;

        gc();

        _setvideomode( _vc_sav.mode );

        return(-1);

}

xoutp( unsigned _port, int _databyte )
{
```

```
        struct rccoord  _rc;
        static short    _tc;
        long            _bk;
        int             _r, _c, _b;
        char            _buff[16];

        _rc = _gettextposition();
        _tc = _gettextcolor();
        _bk = _getbkcolor();

        if( (_port >= DDA06_BASE) && (_port <= DDA06_BASE+0xf) ){
          _r = _port - DDA06_BASE;
          _r >>= 1;
          }

        else{
          _r = 16;
          sprintf( _buff, "0x%04x", _port & 0xfffe );
          LOC(_r,60);
          OTXT( _buff );
          }


        #ifdef DAC_INSTALLED
          outp( _port, _databyte );
        #endif

        _b = (_port & 1) << 1;
        _c = 70 - _b;

        LOC( _r, _c );
        STC( _Yellow );
        sprintf( _buff, "%02x", _databyte );
        OTXT( _buff );

        LOC(_rc.row,_rc.col);
        STC(_tc);
        SBC(_bk);

        CURSOR_ON;
        gc();
        return(-1);

}

int     OutX()
{

        int     _i;
        int     _chan, _bits;
        float   _volts[6];
        char    _buff[256];

        STC(default_textcolor);
```

```
        SBC(default_bkcolor);
        CLS;

        while(-1){

          printf( "\nChannel: ");   scanf( "%d", &_chan );

          if( _chan == -1 )
            break;

          printf( "Output Value: "); scanf( "%d", &_bits ):

          if( _bits == -1 )
            break;

          _chan &= 0x7;
          _bits &=0xfff;

          #ifdef DAC_INSTALLED
          outp( (unsigned)(DDA06_BASE + 2 * _chan),      _bits & 0xff );
          outp( (unsigned)(DDA06_BASE + 2 * _chan + 1), (_bits & 0xf00)
          #endif

          }

        SBC(_Blue);
        CLS;
        return(-1);

}

int     OutDAC()
{

        int      _i;
        int      _chan, _bits, _op_bk;
        float    _volts[6];
        char     _buff[256];
        int      _p3_bits, _p4_bits;
        float    _p3_ma,    _p4_volts;
        float    _p3_ml,    _p4_ml;
        float    _temp_f;
        int      _valve_toggle;
        float    _new_opac, _old_opac, _opac_bk, _old_bk, _temp_opacity_w


         /* ----------------------------------- */
         /*      Initialize                      */
         /* ----------------------------------- */

         _p3_bits = 0;
         _p4_bits = 0;
         _valve_toggle = 0;

         _new_opac = 0.0;
```

```
_old_opac = 0.0;
_opac_bk = 0.0;
_old_bk = 0.0;

_temp_opacity_weight = opacity_weight;

SetV1( _valve_toggle );

#ifdef DAC_INSTALLED
  outp( (unsigned)P3DAC_L8, 0 );
  outp( (unsigned)P3DAC_H4, 0 );

  outp( (unsigned)P4DAC_L8, 0 );
  outp( (unsigned)P4DAC_H4, 0 );
#endif

/* ------------------------------------ */
/*      Display Screen                  */
/* ------------------------------------ */

SBC( _Blue );
STC( _White );
CLS;
CURSOR_OFF;
Start_Up_Message();

LOC( 8, 10 );
STC( _Light_Cyan );
_outtext( "Digital/Analog Output" );

STC( _Light_Green );

/*                        1         2         3         4
                        01234567890123456789012345678901234567:
LOC(10,10);   _outtext( "Peristaltic Pump:   0000     Bits     "
LOC(11,10);   _outtext( "FMI Pump:           0000     Bits     "
LOC(12,10);   _outtext( "Valve (0:Normal/1): 0000              "
LOC(13,10);   _outtext( "Weight Factor:      00.0              "


STC( _Bright_White );

LOC(24,10);
OTXT( "<F1-Enter Variables>  <F2-Read Opacity>  <F3-Read Backgr

LOC(25,10);
OTXT( "<ESC - Return to Main Menu>" );

LOC(10,30);     GetInt( &_p4_bits, 7, _DISPLAY );
LOC(11,30);     GetInt( &_p3_bits, 7, _DISPLAY );
LOC(12,30);     GetInt( &_valve_toggle, 7, _DISPLAY );
LOC(13,30);     GetFloat( &opacity_weight, 7, _DISPLAY );

/* ------------------------------------ */
/*      Enter variables                 */
```

```
/* ----------------------------------- */

ENTER_V:

SetActiveKeys( FKEY2, FKEY3, UP_ARROW, DOWN_ARROW, ESC, 0 );

/* ----------------------------------- */
/*      Peristaltic Pump Rate          */
/* ----------------------------------- */

XXX1:   LOC(10,30);

        _i = GetInt( &_p4_bits, 7, _REPLACE );

        if( (_i==0) && ( (_p4_bits<0) || (_p4_bits>4095) ) ){
          LOC(15,10);
          SBC(_Red);
          OTXT( _cb );
          SBC(_Blue);
          goto XXX1;
          }

        else{
          LOC(15,10);
          SBC(_Blue);
          OTXT( _bl );
          }

        switch(_i){
          case 0:       if( _p4_bits > 4095 )
                          _p4_bits = 4095;

                        if( _p4_bits < 0 )
                          _p4_bits = 0;

                        LOC(10,30);
                        GetInt( &_p4_bits, 7, _DISPLAY );

                        /*
                        #ifdef DAC_INSTALLED
                          outp( (unsigned)P4DAC_L8, _p4_bits & 0
                          outp( (unsigned)P4DAC_H4, (_p4_bits &
                        #endif
                        */

                        break;

          case ESC:             goto _DAC_OUT_EXIT;
          case UP_ARROW:        goto XXX4;
          case FKEY2:           _op_bk = 1;
                                goto DISP_OP;

          case FKEY3:           _op_bk = 0;
                                goto DISP_OP;

          }
```

```
/* ------------------------------------ */
/*      FMI Pump Rate                   */
/* ------------------------------------ */

XXX2:   LOC(11,30);

        _i = GetInt( &_p3_bits, 7, _REPLACE );

        if( (_i==0) && ( (_p3_bits<0) || (_p3_bits>4095) ) ){
          LOC(15,10);
          SBC(_Red);
          OTXT( _cb );
          SBC(_Blue);
          goto XXX2;
          }

        else{
          LOC(15,10);
          SBC(_Blue);
          OTXT( _bl );
          }

        switch(_i){
          case 0:       if( _p3_bits > 4095 )
                          _p3_bits = 4095;

                        if( _p3_bits < 0 )
                          _p3_bits = 0;

                        LOC(11,30);
                        GetInt( &_p3_bits, 7, _DISPLAY );

                        /*
                        #ifdef DAC_INSTALLED
                          outp( (unsigned)P3DAC_L8, _p3_bits & 0
                          outp( (unsigned)P3DAC_H4, (_p3_bits &
                        #endif
                        */

                        break;

          case ESC:             goto _DAC_OUT_EXIT;
          case UP_ARROW:        goto XXX1;
          case FKEY2:           _op_bk = 1;
                                goto DISP_OP;
          case FKEY3:           _op_bk = 0;
                                goto DISP_OP;

          }

/* ------------------------------------ */
/*      Valve Toggle                    */
/* ------------------------------------ */

XXX3:   LOC(12,30);
```

```
_i =  GetInt( &_valve_toggle, 7, _REPLACE );

if( _valve_toggle != 0 ){
  _valve_toggle = 1;
  LOC(12,30);
  GetInt( &_valve_toggle, 7, _DISPLAY );
  }

SetV1( _valve_toggle );

switch(_i){
  case ESC:              goto _DAC_OUT_EXIT;
  case UP_ARROW:           goto XXX2;
  case FKEY2:              _op_bk = 1;
                           goto DISP_OP;
  case FKEY3:              _op_bk = 0;
                           goto DISP_OP;
  }

/* ------------------------------------ */
/*      Opacity Weight                  */
/* ------------------------------------ */

XXX4:   LOC(13,30);

  _i = GetFloat( &opacity_weight, 7, _REPLACE );

  if( (_i==0) && ( (opacity_weight<0) || (opacity_weight>1
    LOC(15,10);
    SBC(_Red);
    OTXT( _cb );
    SBC(_Blue);
    goto XXX4;
    }

  else{
    LOC(15,10);
    SBC(_Blue);
    OTXT( _bl );
    }

  switch(_i){
    case 0:                break;
    case ESC:              goto _DAC_OUT_EXIT;
    case UP_ARROW:         goto XXX3;
    case FKEY2:            _op_bk = 1;
                           goto DISP_OP;
    case FKEY3:            _op_bk = 0;
                           goto DISP_OP;
    }

goto XXX1;
```

```
/* ------------------------------------ */
/*      Read Opacity                    */
/* ------------------------------------ */

DISP_OP:

CURSOR_OFF;

STC(_Bright_White);

LOC(19,10); OTXT( "  Voltage:" );
LOC(19,30); OTXT( "  Bckgrnd:" );
LOC(19,50); OTXT( "  Opacity:" );

SetActiveKeys( FKEY1, FKEY2, FKEY3, ESC, 0 );

opadc.n = 10;
opadcbk.n = 10;

/* ------------------------------------ */
/*      Metering Pump ON                */
/* ------------------------------------ */

LOC(11,30);
GetInt( &_p3_bits, 7, _DISPLAY );

#ifdef DAC_INSTALLED
  outp( (unsigned)P3DAC_L8, _p3_bits & 0xff );
  outp( (unsigned)P3DAC_H4, (_p3_bits & 0xf00) >> 8 );
#endif

/* ==================================== */
/*      Set up for Read Background      */
/* ==================================== */

if( _op_bk == 0 ){

  /* -------------------------- */
  /*    Valve V1 to Drain       */
  /* -------------------------- */

  _valve_toggle = 0;
  LOC(12,30);
  GetInt( &_valve_toggle, 7, _DISPLAY );
  SetV1( _valve_toggle );

  /* -------------------------- */
  /*    Peristaltic Pump OFF    */
  /* -------------------------- */

  _i = 0;

  LOC(10,30);
  GetInt( &_i, 7, _DISPLAY );
```

```
  #ifdef DAC_INSTALLED
    outp( (unsigned)P4DAC_L8, _i & 0xff );
    outp( (unsigned)P4DAC_H4, (_i & 0xf00) >> 8 );
  #endif


  }

/* ==================================== */
/*      Set up for Read Opacity         */
/* ==================================== */

else{

  /* -------------------------- */
  /*     Valve V1 to Mixer      */
  /* -------------------------- */

  _valve_toggle = 1;
  LOC(12,30);
  GetInt( &_valve_toggle, 7, _DISPLAY );
  SetV1( _valve_toggle );

  /* -------------------------- */
  /*    Peristaltic Pump ON     */
  /* -------------------------- */

  LOC(10,30);
  GetInt( &_p4_bits, 7, _DISPLAY );

  #ifdef DAC_INSTALLED
    outp( (unsigned)P4DAC_L8, _p4_bits & 0xff );
    outp( (unsigned)P4DAC_H4, (_p4_bits & 0xf00) >> 8 );
  #endif

  }

/* ==================================== */
/*      Read Loop                       */
/* ==================================== */

while( !kbhit() ){

  if( _op_bk == 1 ){

    ReadADC( &opadc );

    _old_opac = _new_opac;
    _new_opac = opadc.volts;
    _new_opac += ( opacity_weight - 1.0 ) * _old_opac;
    _new_opac /= opacity_weight;

    LOC( 20, 10 );
    sprintf( _buff, "%10.3f", _new_opac );
    OTXT( _buff );
```

```
    LOC( 20, 50 );
    sprintf( _buff, "%10.3f", _new_opac - _opac_bk );
    OTXT( _buff );

    strip_volts = (_new_opac - _opac_bk + 10.0) * 4095.0 / 20.0;

    StripChartOut( strip_volts );

    }

  if( _op_bk == 0 ){

    ReadADC( &opadcbk );

    _old_bk    = _opac_bk;
    _opac_bk   = opadcbk.volts;
    _opac_bk += ( opacity_weight - 1.0 ) * _old_bk;
    _opac_bk /= opacity_weight;

    LOC( 20, 30 );
    sprintf( _buff, "%10.3f", _opac_bk );
    OTXT( _buff );
    }

  }

CURSOR_ON;

switch( gc() ){

  case ESC:      goto _DAC_OUT_EXIT;

  case FKEY1:    goto ENTER_V;

  case FKEY2:    _op_bk = 1;
                 goto DISP_OP;

  case FKEY3:    _op_bk = 0;
                 goto DISP_OP;

  default:       goto DISP_OP;
  }

/* ------------------------------------ */
/*      Return                          */
/* ------------------------------------ */

_DAC_OUT_EXIT:

SetV1( _V1_DEFAULT );

#ifdef DAC_INSTALLED
  outp( (unsigned)P3DAC_L8, 0 );
  outp( (unsigned)P3DAC_H4, 0 );
```

```
          outp( (unsigned)P4DAC_L8, 0 );
          outp( (unsigned)P4DAC_H4, 0 );
        #endif

        if( opacity_weight != _temp_opacity_weight )
          Write_Opacity_File();

        CLS;
        return(-1);


}

int     SetP3( float _rate )
{

        /* -------------------------------------------- */
        /*      Set Metering Pump Flow Rate             */
        /* -------------------------------------------- */

        int     _bits, _l8, _h4;

        if( _rate > rp3_max )
          return(0);

        if( _rate < 0.0 )
          return(0);

        _$p3_rate = _rate;

        _bits = ( _rate / rp3_max ) * 4095.0;

        /*
        LOC(25,1);
        printf( "P3:%4d", (_bits & 0xfff) );
        */

        _l8 = (_bits & 0xff);
        _h4 = ( (_bits & 0xf00) >> 8 );

        #ifdef DAC_INSTALLED
          outp( P3DAC_L8, _l8 );
          outp( P3DAC_H4, _h4 );
        #endif

        return(-1);

}

int     InitPIO24()
{

        #ifdef PIO_INSTALLED
          outp( PIO_CONTROL, 0 );
```

```
        #endif

        return(-1);

}

int     SetV1( int _open_close )
{

        #ifdef PIO_INSTALLED
          outp( PA, _$v1 = _open_close );
       #endif

        return(-1);

}

int     GetP3( float *_rate )
{
        *_rate = _$p3_rate;
        return(-1);
}

int     GetP4( float *_rate )
{
        *_rate = _$p4_rate;
        return(-1);
}

int     GetV1( )
{

        return( _$v1 );

}

int     SetP4( float _rate )
{

        /* ---------------------------------------------- */
        /*      Set Peristaltic Pump Flow Rate            */
        /*                                                */
        /*      Note: Pump control voltage is             */
        /*      0-5 Volts DC.  D/A Converter must         */
        /*      be set to 5 Volt Unipolar Range.          */
        /* ---------------------------------------------- */

        int     _bits, _l8, _h4;

        if( _rate > rp4_max )
          return(0);

        if( _rate < 0.0 )
          return(0);
```

```
        _$p4_rate = _rate;

        _bits = ( _rate / rp4_max ) * 4095.0;

        /*
        LOC(25,10);
        printf( "P4:%4d", (_bits & 0xfff) );
        */

        _l8 = (_bits & 0xff);
        _h4 = ( (_bits & 0xf00) >> 8 );

        #ifdef DAC_INSTALLED
          outp( P4DAC_L8, _l8 );
          outp( P4DAC_H4, _h4 );
        #endif

        return(-1);

}

int     Init_ADC()
{


        h4adc.v_range    = 10.0;
        h4adc.fs_bits    = 4096.0;
        h4adc.b_offset   = 0.0;
        h4adc.v_offset   = h4adc.b_offset * h4adc.v_range / h4adc.fs_bits
        h4adc.gain       = UNIPOLAR_10V;
        h4adc.channel    = ADC_H4_PRESSURE_SENSOR;
        h4adc.n          = 1;

        opadc.v_range    = 20.0;
        opadc.fs_bits    = 4096.0;
        opadc.b_offset   = 2048.0;
        opadc.v_offset   = opadc.b_offset * opadc.v_range / opadc.fs_bits
        opadc.gain       = BIPOLAR_10V;
        opadc.channel    = ADC_OPACITY_METER;
        opadc.n          = 1;

        opadcbk.v_range    = 20.0;
        opadcbk.fs_bits    = 4096.0;
        opadcbk.b_offset   = 2048.0;
        opadcbk.v_offset   = opadcbk.b_offset * opadcbk.v_range / opadcbk
        opadcbk.gain       = BIPOLAR_10V;
        opadcbk.channel    = ADC_OPACITY_METER;
        opadcbk.n          = 1;

        aux.v_range    = 10.0;
        aux.fs_bits    = 4096.0;
        aux.b_offset   = 2048.0;
        aux.v_offset   = aux.b_offset * aux.v_range / aux.fs_bits;
        aux.gain       = BIPOLAR_5V;
        aux.channel    = ADC_AUX;
```

```
        aux.n           = 1;

        return(-1);

}

int     ReadADC( _ADC *_a )
{

        int     _h8, _l4, _bits, _stat, _i;
        long    _sum;

        /* ------------------------------------ */
        /*      Select Gain and Channel         */
        /* ------------------------------------ */

        #ifdef ADC_INSTALLED
          outp( ADC_GAIN_CONTROL, _a->gain );
          outp( ADC_CONTROL, _a->channel );
        #endif

        /* ---------------------------- */
        /*      Sum n conversions       */
        /* ---------------------------- */

        for( _i=_a->n, _sum=0; _i!=0; --_i ){

          #ifdef ADC_INSTALLED

          outp( ADC_START_12_BIT, 0 );

          do
            _stat = inp( ADC_STATUS );

          while
            ( _stat & 0x80 );

          _l4 = inp( ADC_L4 );
          _h8 = inp( ADC_H8 );

          #endif

          _sum += (  ( _l4 >> 4 )  |  ( _h8 << 4 )  );

          }

        _a->volts       = _sum / (float)_a->n;
        _a->bits        = _a->volts;

        _a->volts       -= _a->b_offset;
        _a->volts       *= (_a->v_range / _a->fs_bits);

        return(-1);

}
```

```
int      FastReadADC()
{

        /* ------------------------------------------------------------ */
        /*       FastReadADC assumes that channel & gain                */
        /*       have been selected by caller.                          */
        /* ------------------------------------------------------------ */

        int      _h8, _l4, _bits, _stat;

        #ifdef ADC_INSTALLED

        outp( ADC_START_12_BIT, 0 );

        do
          _stat = inp( ADC_STATUS );

        while
          ( _stat & 0x80 );

        _l4 = inp( ADC_L4 );
        _h8 = inp( ADC_H8 );

        #endif

        return(  ( _l4 >> 4 )  |  ( _h8 << 4 )  );

 }

 int     StripChartOut( float _volts ){

             int _bits;

             _bits = _volts;

             if( _bits > 4095 )
               _bits = 4095;

             if( _bits < 0 )
               _bits = 0;

             #ifdef DAC_INSTALLED
               outp( STRIP_CHART_L8, (_bits & 0xff) );
               outp( STRIP_CHART_H4, (_bits & 0xf00) >> 8 );
             #endif

             return(-1);

  }
```

```c
/* *********************************************************************
/*      SetUp.C, DOE S & ASH ANALYZER, B&W RDD 4554
/* *********************************************************************

#include        < Graph.H >
#include        < Colors.H >
#include        < Stdio.H >
#include        < StdLib.H >
#include        < String.H >
#include        < Dos.H >
#include        < Io.H >
#include        < Keys.H >

#include        "Sa.H"
#include        "Proto.H"

#define         TEST_TITLE_LENGTH 32
#define         NAME_OUT_LENGTH 32

char            test_title[TEST_TITLE_LENGTH];
char            name_out[NAME_OUT_LENGTH];

SetUp()
{

        int             _r, _c, _i, _j, _k;
        unsigned        _ui;
        char            _str[80], _buff[80];
        struct rccoord  _rcgofn;
        char            _drive[_MAX_DRIVE], _dir[_MAX_DIR];
        char            _fname[_MAX_FNAME], _ext[_MAX_EXT];


        _r = 2;
        _c = 5;

        CURSOR_ON;

        SBC(_Blue);
        CLS;

        STC(_Bright_White);
        LOC(  _r, _c ); _outtext( "Setup Routine: " );
        STC(_Light_Green);
        LOC(++_r, _c ); _outtext( "Set operating paramaters" );
        LOC(++_r, _c ); _outtext( "and name files." );

        /* -------------------------------------------- */
        /*      Get output file name                    */
        /* -------------------------------------------- */

        SetActiveKeys( 0 );

        _rcgofn.row = _r;
        _rcgofn.col = _c;
```

```
GOFN:

STC( _Light_Green );

LOC( _r+=2, _c+2 ); _outtext( "Name the output file to" );
LOC( ++_r,  _c+2 ); _outtext( "which data will be stored: " );

STC( _Black ); SBC( _Light_Cyan );
GetString( name_out, NAME_OUT_LENGTH-2 );

for( _i = NAME_OUT_LENGTH - 3; name_out[_i] == ' '; --_i );
name_out[++_i] = '\0';

_splitpath( name_out, _drive, _dir, _fname, _ext );

if( _drive[0] == '\0' ){
  _dos_getdrive( &_ui );
  switch( _ui ){
    case 1:     strcpy( _drive, "A:" ); break;
    case 2:     strcpy( _drive, "B:" ); break;
    case 3:     strcpy( _drive, "C:" ); break;
    case 4:     strcpy( _drive, "D:" ); break;
    case 5:     strcpy( _drive, "E:" ); break;
    default:    break;
    }
  }

_makepath( name_out, _drive, _dir, _fname, _ext );

LOC( _r+=2, _c );
SBC(_Blue);

/* ------------------------------------ */
/*      Check for RESERVED FILE NAME    */
/* ------------------------------------ */

if( Is_Reserved_File( name_out ) ){

  STC( _Bright_White );
  sprintf( _buff, "\"%s\" is a reserved file name.", name_out );
  _outtext( _buff );

  gc();

  _j=0;

  while( _buff[_j] != '\0' )
    _buff[_j++] = ' ';

  LOC( _r, _c );
  _outtext( _buff );

  strcpy( name_out, "" );
```

```
  _r = _rcgofn.row;
  _c = _rcgofn.col;

  goto GOFN;

  }

/* ------------------------------------------ */
/*       If output file exists, overwrite ?     */
/* ------------------------------------------ */

if( access( name_out, 00 ) == 0 ){

  STC( _Bright_White );
  sprintf( _buff, "\"%s\" Already Exists, Overwrite (Y/N) ? ", n
  _outtext( _buff );

  _i = gc();

  _j=0;

  while( _buff[_j] != '\0' )
    _buff[_j++] = ' ';

  LOC( _r, _c );
  _outtext( _buff );

  if( (_i=='n') || (_i=='N') ){

    strcpy( name_out, "" );

    _r = _rcgofn.row;
    _c = _rcgofn.col;

    goto GOFN;

    }
  }

/* ------------------------------------ */
/*       Display output filename         */
/* ------------------------------------ */

STC( _Bright_White );
LOC( _r, _c ); _outtext( "Output filename: " );

STC( _Light_Cyan );
LOC( _r, _c+18 ); _outtext( name_out );

/* ------------------------------------ */
/*       Input Title of Test             */
/* ------------------------------------ */

LOC( _r+=2, _c+2 ); STC( _Light_Green );
sprintf( _buff, "Title of Test: " );
```

```
        _outtext( _buff );

        STC( _Black ); SBC( _Light_Cyan );
        GetString( test_title, TEST_TITLE_LENGTH-2 );

        /* ------------------------------------ */
        /*      Print Variable Descriptions     */
        /* ------------------------------------ */

        STC(_Light_Green); SBC(_Blue); CLS;

/*                        1         2         3         4         5
/*                 45678901234567890123456789012345678901234567890123456789
LOC( 2,4); OTXT("Rate at which dilution pump will be operated
LOC( 3,4); OTXT(" when not taking opacity measurments: 000.00 mL/min.

LOC( 5,4); OTXT("Rate at which dilution pump will be operated during opa
LOC( 6,4); OTXT(" measurments and second flush period: 000.00 mL/min.

LOC( 8,4); OTXT("Rate at which dilution pump will be operated during opa
LOC( 9,4); OTXT(" sensor auto-calibrate flush period:  3240   bits.");

LOC(11,4); OTXT("Length of time (seconds) for each opacity reading
LOC(12,4); OTXT(" period:

LOC(14,4); OTXT("  Increase P3        0000 seconds");
LOC(15,4); OTXT("  Read Background    0000 seconds");
LOC(16,4); OTXT("  Read Opacity       0000 seconds");
LOC(17,4); OTXT("  Flush              0000 seconds");
LOC(18,4); OTXT("  Decrease P3        0000 seconds");

LOC(20,4); OTXT("  Solids            0.000 \%" );
LOC(21,4); OTXT("  P4 Cal. Rate      0.000 mL/min." );

LOC(14,40); OTXT( "Solids Equation Coefficients:" );
LOC(15,40); OTXT( " B0" );
LOC(16,40); OTXT( " B1" );
LOC(17,40); OTXT( " B2" );

        /* ------------------------------------------- */
        /*      Print Active Keys                      */
        /* ------------------------------------------- */

        STC(_Bright_White); SBC(_Blue);

        LOC( 24, 2 ); _outtext(
        "< DownArrow = Next Cell >   < UpArrow = Previous Cell >" );

        LOC( 25, 2 ); _outtext(
        "< CR = Enter >              < F1 = Accept All >" );

        SetActiveKeys( UP_ARROW, DOWN_ARROW, FKEY1 );

        /* ------------------------------------------- */
        /*      Print Variables to screen              */
```

```
/* --------------------------------------- */

STC( _Black ); SBC( _Light_Cyan );

LOC( 3, 42 );    GetFloat( &rp3_lo_set, 6, _DISPLAY );
LOC( 6, 42 );    GetFloat( &rp3_hi_set, 6, _DISPLAY );
LOC( 9, 42 );    GetInt( &rp3_flush_bits, 5, _DISPLAY );
LOC( 14, 23 );   GetInt( &increase_p3_t, 4, _DISPLAY );
LOC( 15, 23 );   GetInt( &background_t, 4, _DISPLAY );
LOC( 16, 23 );   GetInt( &read_opacity_t, 4, _DISPLAY );
LOC( 17, 23 );   GetInt( &flush_t, 4, _DISPLAY );
LOC( 18, 23 );   GetInt( &decrease_p3_t, 4, _DISPLAY );

LOC( 20, 22 );   GetFloat( &percent_solids, 5, _DISPLAY );
LOC( 21, 22 );   GetFloat( &p4_cal_rate, 5, _DISPLAY );

LOC( 15, 45 );   GetFloat( &b0, 10, _DISPLAY );
LOC( 16, 45 );   GetFloat( &b1, 10, _DISPLAY );
LOC( 17, 45 );   GetFloat( &b2, 10, _DISPLAY );

XX1:    LOC( 3, 42 );
        switch( GetFloat( &rp3_lo_set, 6, _REPLACE ) ){
          case FKEY1:            goto ACCEPT_ALL;
          case UP_ARROW:         goto XX13;
          }

XX2:    LOC( 6, 42 );
        switch( GetFloat( &rp3_hi_set, 6, _REPLACE ) ){
          case FKEY1:            goto ACCEPT_ALL;
          case UP_ARROW:         goto XX1;
          }

XX3:    LOC( 9, 42 );
        switch( GetInt( &rp3_flush_bits, 5, _REPLACE ) ){
          case FKEY1:            goto ACCEPT_ALL;
          case UP_ARROW:         goto XX2;
          }

XX4:    LOC( 14, 23 );
        switch( GetInt( &increase_p3_t, 4, _REPLACE ) ){
          case FKEY1:            goto ACCEPT_ALL;
          case UP_ARROW:         goto XX3;
          }

XX5:    LOC( 15, 23 );
        switch( GetInt( &background_t, 4, _REPLACE ) ){
          case FKEY1:            goto ACCEPT_ALL;
          case UP_ARROW:         goto XX4;
          }

XX6:    LOC( 16, 23 );
        switch( GetInt( &read_opacity_t, 4, _REPLACE ) ){
          case FKEY1:            goto ACCEPT_ALL;
          case UP_ARROW:         goto XX5;
          }
```

```
XX7:    LOC( 17, 23 );
        switch( GetInt( &flush_t, 4, _REPLACE ) ){
          case FKEY1:              goto ACCEPT_ALL;
          case UP_ARROW:           goto XX6;
          }

XX8:    LOC( 18, 23 );
        switch( GetInt( &decrease_p3_t, 4, _REPLACE ) ){
          case FKEY1:              goto ACCEPT_ALL;
          case UP_ARROW:           goto XX7;
          }

XX9:    LOC( 20, 22 );
        switch( GetFloat( &percent_solids, 5, _REPLACE ) ){
          case FKEY1:              goto ACCEPT_ALL;
          case UP_ARROW:           goto XX8;
          }

XX10:   LOC( 21, 22 );
        switch( GetFloat( &p4_cal_rate, 5, _REPLACE ) ){
          case FKEY1:              goto ACCEPT_ALL;
          case UP_ARROW:           goto XX9;
          }

XX11:   LOC( 15, 45 );
        switch( GetFloat( &b0, 10, _REPLACE ) ){
          case FKEY1:              goto ACCEPT_ALL;
          case UP_ARROW:           goto XX10;
          }

XX12:   LOC( 16, 45 );
        switch( GetFloat( &b1, 10, _REPLACE ) ){
          case FKEY1:              goto ACCEPT_ALL;
          case UP_ARROW:           goto XX11;
          }

XX13:   LOC( 17, 45 );
        switch( GetFloat( &b2, 10, _REPLACE ) ){
          case FKEY1:              goto ACCEPT_ALL;
          case UP_ARROW:           goto XX12;
          }

goto XX1;

/* -------------------------------------------- */
/*      Return                                  */
/* -------------------------------------------- */

ACCEPT_ALL:

Write_P3_File();
Write_P4_File();
Write_H4_File();
Write_Opacity_File();
```

```
        SBC(_Blue);
        CLS;

        return(-1);

}
```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